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The proposed tunnel railway scheme of the New York & Long Island Railway Co. was revived at the last stockholders' meeting, by voting to increase the stock from $100,000 to $20,000,000 for this purpose; provided that the consent of the Railway Commissioners of New York and New Jersey can be obtained. This company proposes to build 26 miles of double-track railway, beginning in New Jersey, and to tunnel under the Hudson River, under 42nd street, and under the East River to Long Island. The directors elected were: William Steinway, H. S. Kearney, H. E. Kleber, Louis Von Bernuth, Walter J. Foster, John Bogart, A. G. Mills, W. D. Baldwin, Herbert Steward, Malcolm W. Niven, Edward A. Greene, H. D. Low, all of New York, and A. J. Benedict, of London.

The new gravity water supply for Seattle, Wash., for which $1,250,000 was voted on Dec. 10, will be constructed substantially in accordance with recommendations made by Mr. Benezette Williams in 1890. The supply will be from a point on Cedar River, about 25 miles from, and 500 ft. above, the lowest portion of the city. The original plan was to throw a timber and earth dam, 21 ft. high above low water, across the river, and conduct 5,000,000 gallons a day through a V-shaped flume to Swan Lake, about eight miles distant. This lake has a water surface of about 600 acres and is 468 ft. above tide. A dam at its outlet was proposed, raising its level to 485 ft. and increasing the water surface to 800 acres. The location of the lake is such that it saves about 2½ miles in the length of the proposed conduit. It was proposed to draw water from the lake through a tunnel one mile long and a 42-in. pressure conduit 14 miles long to a reservoir at 300 ft. elevation, and then continuing 2½ miles further to another reservoir at 425 ft. elevation, for high service. The supply conduit was designed to be of wood. The present plan includes a 40,000,000 and a 25,000,000-gallon distributing reservoir within the city. Plans and specifications for this work are being prepared by Mr. Reginald H. Thomson, City Engineer, to whom we are indebted for the above information. Bids will be asked on both riveted steel and wood stave pipe for the conduit.

Lead water service pipes at Kingston, Mass., have been declared dangerous by the State Board of Health, according to reports. It is stated that the water contains a sufficient amount of acid to liberate the lead from the pipes, thus charging the water with this poison.

The tug "Tamaqua," lately launched at the Cramp's shipyard in Philadelphia, is the largest vessel of this type ever built in this country. She is 170 ft. long, 29 ft. beam and 18 ft. depth of hold. The engines are triple-expansion, with 18, 28 and 45-in. cylinders, and 30-in. stroke. This tug was built for the Philadelphia & Reading R. R. Co.

The new East River Bridge Commissioners have bought the Uhlmann charter for $200,000. This charter is held to be valid, and it covers the best and most economical site for the new structure. To place the bridge either above or below the Uhlmann line would have cost an additional million, according to Mayor Schieren, and to have acquired the right by condemnation would have necessitated a delay of at least 15 months, with heavy legal expenses added. It is said that a rock foundation has been found by the engineers on both sides and under favorable conditions for construction.

The contracts for the regulating works for the Chicago Drainage Channel has been awarded to Christie & Lowe, of Chicago, Ill., the aggregate of whose prices for all different parts of the work proved to be the lowest. Previous to being awarded the contract the successful bidders agreed to accept still lower prices than those bid for certain parts of the work. The prices now stand as follows: Sluice gates, above elevation, 17.75, $120,000; masonry below 17.75, $11 per cu. yd.; concrete below 17.75, $5 per cu. yd.; excavation, 59 cts. per cu. yd.; bear trap dam, $58,000. These regulating works were described in detail in our issue of Nov. 21.

The actual revenue of the North Sea and Baltic Ship Canal, as officially published in the "Reichsanzeiger," was $58,410, for canal and towage dues in the months of July, August and September last. In July the revenue was $15,795; August, $20,570, and in September, $22,045. This is at the rate of only $197,640 per annum, upon an enterprise that cost about $39,000,000. The dues levied are nearly 15 cts. per ton up to 600 registered tons, and 9½ cts. for every additional ton. Vessels in ballast, and coasting vessels of less than 50 tons pay 9½ cts. per ton. Towage of sailing vessels by canal tugs costs 9½ cts. per ton, up to 200 registered tons, and 7¾ cts. for every additional ton. For the towing of unloaded vessels these charges are reduced to 6 cts., and 4¾ cts. respectively. In the six months between October and March these dues are increased 25%.

The partial flooding of the Chicago Drainage Channel by the recent heavy rains, has caused a protest to be raised by some of the contractors against standing the expense of pumping their sections dry. It is estimated that about 27,000,000 gallons of water are in the completed and partly completed sections. According to the specifications the contractors are required to keep their sections drained at their own expense, but the cost of removing the present flood water has apparently determined some of them to attempt to fight this requirement. Protest has already been made by Wier & McKechney, contractors for section F, on which there is estimated to be some 4,000,000 gallons in the pit.

The Lake View intake tunnel extension for the Chicago water-works is nearly completed. It was begun in 1889 by Lake View, before annexation to Chicago. The original section, 6,000 ft. in length, was put in use in 1892. The extension makes the tunnel two miles long. The contractors are Shailer & Schiglau, of Chicago. The tunnel is 8 ft. in diameter and its cost will be about $500,000, according to reports.

The most serious railway accident of the week was a head collision on a sidetrack at Schooley's, O., on the Baltimore & Ohio Southwestern R. R., Jan. 4. Two freight trains had been on the sidetrack, and when the first one pulled out the conductor left the switch open, supposing the second train would follow at once. This train, however, had orders to wait, and in the meantime an express train came up and was turned onto the sidetrack by the open switch. Five trainmen and a mail clerk were killed, and another trainman and a mail clerk were injured.

A landslide near Georgetown, Pa., occurred Dec. 31, on the line of the Pennsylvania R. R., just as a freight train was passing. The engine and five cars were carried into the river, and six other cars were buried in the slide, which was about 300 ft. long and 25 ft. deep. Five men were injured.

A grade crossing collision between a Philadelphia & Reading R. R. train and an electric car occurred at Philadelphia, Pa., Dec. 30, at Ninth St. and Montgomery Ave. The gates were down, but the car got beyond control on the slippery track and the down grade, and smashed through the gates. It was then struck by the engine of an incoming train, but the train was stopped before the car was entirely overturned. Nobody was seriously hurt.

A freight train on the Louisville & Nashville R. R. ran into an open draw in the trestle over the Rigolets, near New Orleans, La., Jan. 7. Three men were drowned.

Quicksand in the Northwest water-works tunnel, now under construction in Chicago, caused a small cave in of the overlying sand and gravel, on Jan. 4. The accident took place at the heading, about 400 ft. from a shaft, and, owing to ample warning received, no one was injured. No great difficulty was found in stopping the inflow of material by ordinary timbering, and it is thought that $2,000 will cover the damage. At the point of the accident the tunnel is 8 ft. in diameter. Mr. J. J. Duffy, of Chicago, is the contractor.

A grindstone weighing 2,700 lbs. burst at the works of G. W. & W. G. Lavers, in Montebello, Mass., on Jan. 3. The cause was the breaking of the governor belt and consequent racing of the shop engine.

A combined boiler and fireworks explosion took place in St. Louis on Jan. 2, killing seven persons and injuring several others, and causing a damage to property estimated at over $100,000. A boiler in a printing office in North Third St. first exploded, and this was followed by an explosion of a lot of fireworks stored in the rear of a building across an alley from the printing office, and immediately afterward by another explosion of fireworks within the building, which completely wrecked it.

A boiler exploded at Ross's Pavilion, on the pier in Ocean Grove, N. J., on Dec. 27. The engineer was slightly injured. The boiler left its position, rose high in the air, and descended in a graceful curve into the ocean. As the boiler thus took itself out of the reach of an investigation, the cause of the explosion will probably never be ascertained.

A laundry mangle exploded at the Hyde Park Hotel, Chicago, on Dec. 23, wrecking the laundry, causing a damage of about $1,000, and slightly injuring two men. The cause is supposed to be a flaw in a casting.

A boiler explosion occurred at the Law shaft of the Pennsylvania Coal Co. at Avoca, Pa., on Dec. 31, by which three men were instantly killed. The cause is reported in the press dispatches to be scarcity of water in the boiler, but it is also stated that the boiler had been condemned by an inspector as unsafe some time ago.

The boiler of a 110-ton freight locomotive exploded at Clipper Gap, Cal., on Dec. 22 blowing out the crown sheet and also the head end of the boiler.

Four dynamite explosions occurring inside of six days and following a week or two after a similar series of steam-pipe explosions give support to the peculiar theory of the law of chances that "accidents never come singly." The first of the four took place at New Rochelle, N.Y., on Dec. 21, killing two Italians and causing a third to become temporarily insane from fright and shock. The houses near by were swayed by the explosion and many windows were broken. The dynamite was being used in some railway improvements, and, according to a statement by the foreman of the workmen, the three Italians were left to guard 12 sticks of dynamite that had been dried out. There was a little fire about 7 ft. distant. It is not known how the dynamite became ignited.

The second explosion took place on section 14 of the Chicago Drainage Canal, near Romeoville, Ill., on Dec. 22, killing two men and injuring seven others. It is said to have been caused by the carelessness of a foreman, who prematurely exploded a blast while the men were working in the bed of the channel.

The third was the explosion of the magazine of the Smithdeal Hardware Co., near Salisbury, N. C., on Dec. 24, killing one and injuring the other of two boys who were hunting near by. It is supposed that a bullet entered the magazine, which contained 1,500 lbs. of dynamite and 50 kegs of powder.

The fourth, and apparently the heaviest explosion, also took place on the Chicago Drainage Canal, at Lockport, Ill., 30 miles from Chicago, on Dec. 27. A magazine containing 2,000 lbs. of dynamite exploded. No one was injured, but the shock was sufficient to wake all the people in Chicago at 4 A. M., and to frighten the residents of the country for 50 miles in every direction. The large cranes used on Smith & Eastman's section of the canal were damaged, and two boarding houses a quarter of a mile from the magazine were almost shaken from their foundation, throwing the inmates from their beds. Nothing but a hole in the ground 12 ft. square remains on the former site of the magazine. Hundreds of windows in Joliet and Lockport were shattered.

An Indiana and Ohio ship canal is the subject of a bill to be introduced into Congress by Mr. Hatch, of Laporte, Ind. The bill will ask for an appropriation for a survey of this proposed canal, from Michigan City to Toledo, O.

THE USE OF A GIN-POLE FOR ERECTING A WATER TOWER AT MONTEZUMA, IA.

In the erection of the hundreds of stand-pipes, water tanks and their supporting towers throughout the United States much ingenuity has been shown in the employment of methods designed to effect quick work at a low cost. One of the most interesting of these methods has just been brought to our attention by Mr. J. F. Jackson, Assoc. M. Am. Soc. C. E., Superintendent of Erection for the contractors, the Wisconsin Bridge & Iron Co., of Milwaukee. The photograph sent by Mr. Jackson has been reproduced and is presented herewith. The work in question can best be described in Mr. Jackson's own language, as follows:

Gentlemen: Enclosed please find photograph of a gin-pole used by the Wisconsin Bridge & Iron Co. in erecting a square tower for a water tank support at Montezuma, Ia. The tower was 33 ft. square at the base and 100 ft. high. The heaviest girder at the top weighed about two tons.

The gin-pole was made 4 ft. square of four 4 × 4-in. pine scantling in 16-ft. lengths, and the bracing was made of 1 × 5-in. boards. A section of the pole, 48 ft. in length, was made on the ground, erected, and held by guy ropes, after which it was lengthened as required by splicing on one piece of timber at a time, which was easily and quickly done by two men at the top of the pole. The total height was 114 ft.

The pole served its purpose very satisfactorily, and was perfectly rigid, while it was no heavier than an 8x10 solid pole of the same length would have been After the tower and tank were completed, this gin-pole was boarded up on all four sides and forms the frost box protecting the supply pipes leading from the ground to the bottom of the tank.

A RAILWAY DIVISION AND ITS WORK.

(Delaware Division; New York, Lake Erie & Western R. R.)

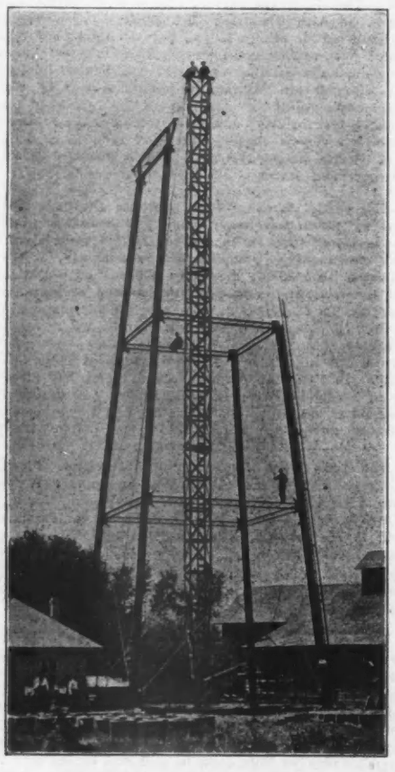
A railway division is a little railway system in itself, both as to organization and management and equipment, and the proper management of a division calls for as much care and attention to detail, in order to ensure efficiency, economy and general satisfaction to the company and its customers, as does the management of an entire railway. There is probably no position which so well trains a man for railway management as that of division superintendent, especially when he is in sole charge of the work of the division, as the superintendent is in actual touch with his subordinates and superior officers, and knows (or should know) all about the property and men on the division. The management of the men and the traffic calls for much exercise of patience, complaisance and ingenuity, and requires a capacity for forethought, readiness of thought and action, and ability to see both sides of a question and decide the merits thereof. The conditions vary on every road and division, and with every superintendent, but we publish herewith some notes on the equipment and work of a railway division which may be taken as illustrative of the general conditions and operations. The division with which we deal is the Delaware Division of the New York, Lake Erie & Western R. R., and the article has been prepared by a member of the staff of this journal after some interesting trips over the division.

Organization.

The organization of the staff differs, of course, on nearly every railway, but on the New York, Lake Erie & Western R. R. the division superintendent is in charge of the entire work on the division, including the maintenance of way, the providing and caring for the motive power and equipment, and the movement of passenger and freight traffic. He has under him a trainmaster, chief train dispatcher, roadmaster and master mechanic, and reports to the general superintendent and superintendent of transportation. In practice, the trainmaster looks after the proper distribution of the engines to haul the trains, while the dispatcher looks after the distribution of cars and sees that enough are provided for the freight to be handled from any point, while so disposing of the available supply as to cause the least practicable mileage of empty cars. Every morning a return is made to the superintendent of the number of engines and cars available for the train service, and there is a conference between the superintendent, trainmaster, dispatcher and master mechanic, as to the work required and the method of carrying it out. The trainmaster acts in the place of the superintendent during the absence of the latter. He employs brakemen and recommends men for appointment as conductors and enginemen, and conducts the prescribed examination of trainmen in every grade of train service. He also attends to the prompt movement of passenger and fast freight trains, sees that the proper number of cars is moved in each freight train, and that no more freight trains are run than are actually required.

The roadmaster reports to and receives instructions from the superintendent, and has under him the supervisors (in charge of subdivisions) and master carpenters, who attend to repairs of buildings, water tanks, pumping stations, .

The section foremen are under the supervisors, and give instructions to the trackmen and road



Gin-Pole used in Erecting Supporting Tower for Water Tank at Montezuma, Ia.
Wsconsin Bridge & Iron Co., Milwaukee, Contractors.
J. F. Jackson, Assoc. M. Am. Soc. C. E., Superintendent of Erection.

and bridge watchmen. Switchtenders are under the direction of the station agents, except in yards, where they are under the direction of the yardmaster or stationmaster, who in turn are under the superintendent and trainmaster. The yardmasters also obey instructions from the station agents.

Mr. W. L. Derr is superintendent of this division; Mr. E. T. Reisler is roadmaster; Mr. O. Reynolds, trainmaster; Mr. J. H. Glasier, chief train dispatcher, and Mr. Jos. Hainen, master mechanic.

Physical Characteristics.

The Delaware Division extends from Port Jervis, N. Y., to Susquehanna, Pa., a distance of 104 miles, and includes the branch from Lackawaxen to Honesdale, 24 miles. For about 30 miles from Port Jervis the line is on the west bank of the Delaware river, being benched out of the steep cliffs, with steep slopes or vertical walls on the river side and high vertical walls of rock on the other side. The track is at a considerable height (about 60 ft.) above the river on this part, but descends later on and crosses to the other side of the valley, being then at the foot of a long steep slope covered with loose, shattered rock, which gives considerable trouble in the winter. It is proposed to attempt to improve these slopes by tile drainage.

At Port Jervis connection is made with the Port Jervis, Monticello & New York R. R. to Monticello, N. Y., 24 miles, and Summitville, 22 miles. At Lanesboro, two miles east of Susquehanna, there is connection with the Jefferson Division of the New York, Lake Erie & Western R. R., from Carbondale, Pa., and a considerable amount of coal traffic is received from that division. Near Hancock, the line is crossed by the New York, Ontario & Western R. R., but there is no connection.

Grades.

The general grade line is ascending northward from Port Jervis to within a few miles of Susquehanna, Pa. From Deposit the line ascends the divide separating the Delaware and Susquehanna valleys by a grade of 0.93 and 1.08%, about 7 miles long to the summit, and then descends by a grade of 1.12% along the side of the Susquehanna valley to Susquehanna. On both these grades pusher engines are used for heavy freight trains, and on the latter grade, 8 miles long, the pushers are enormous decapod engines, on the four-cylinder compound system of the Baldwin Locomotive Works, as noted further on.

Alinement.

The alinement is very crooked, the curvature aggregating about 70% of the total. The line and surface of the track are in excellent condition and easy riding of the trains on entering and leaving curves is ensured by the use of spiral transition curves, laid out on the Holbrook system.

The super-elevation is attained in the spiral, not running out on the tangent, as in the case of untransitioned curves, and stakes are set at the P. C. and P. S. C. giving the elevation required for the curve. The curves on this division are all numbered and indicated by small board signs on short stakes. This arrangement much facilitates giving instructions as to track work required, etc., at any point. The gage is only widened on curves of more than 3° and the maximum widening is ½ in.

Track.

The division is double-tracked throughout, but the tracks are 13 ft., c. to c., instead of the more usual spacing of 12 ft., this being due to the change of gage effected in 1878 from the old 6 ft. Erie R. R. broad gage to standard gage.

The track is laid with 74 and 80-lb. rails, the former having three-tie joints spliced by 42-in. angle bars and six bolts spaced 8, 7, 6, 7 and 8 ins. c. to c., and the latter having suspended joints (with joint ties about 10 ins. apart) spliced by 36-in. angle bars, with bolts spaced 4¾, 4¾, 4¼, 4¾ and 4¾ ins. In some cases the heavier rail is used on the outside, and the lighter rail on the inside of curves, but no special effect on the wear or on the riding of the trains has been observed. There are about 16 ties to a rail length, and many of the ties are of exceptional width, even as much as 12 or 13 ins. The ties are mainly of oak from West Virginia costing 65 cts. each, delivered. The ordinary Servis tie-plates are largely used, being placed on the joint and quarter ties on open track (six plates to each rail) and on all the ties of some of the bridges. They are found to hold firmly to the ties and cause no rattling. In applying them, the spikes are drawn and the rail is slightly lifted to allow of the plate being slipped underneath. An iron plate is then put between the tie-plate and rail, and two spikers strike the projecting ends of this plate simultaneously with their mauls, driving the tie-plate down uniformly and not bending or buckling it as is sometimes done where it is struck direct by the maul.

On the Starucca viaduct the Servis ribbed tie-plate is used on every tie, the rib across the top having a gap which makes a tight fit for the rail base. Ordinary spike fastenings are used for the rails, except on some of the bridges where the improved Bush interlocking bolts (with straight bolts) are used. A good plan carried out on this division is to send two spikers over each section twice a

year, these men driving down every spike and replacing all broken spikes with new ones. This of course is in addition to the incidental spiking by trackwalkers and section men. Rail braces are used on curves on the older track, but in new work tie-plates will be used and braces dispensed with. The method adopted here for renewing rails is to lay in one rail at a time, as it is considered that by stringing them in long lines after having been bolted up on the outside of the ties, the splice bars are liable to get kinked and bent when the string of rail is thrown in and lined up by bars. The ballast is partly of coarse stone, and partly of cinders and gravel. In regard to the stone, it is considered that it causes too many voids or spaces, which it would be better to fill up with finer material. Stone ballast on a poor road also involves greater expense for renewal and maintenance of ballast (perhaps at a time when little money is available) than where gravel is used.

The division has three sub-divisions, each in charge of a track supervisor, and the sub-divisions have respectively, 7, 9 and 11 sections, each from 5 to 6 miles long. In spring and autumn, when the track work is heaviest, the section gangs consist of about 9 men and a foreman, but at other seasons they are cut down to about 5 men and a foreman. Besides the section men there are watchmen employed where the line is benched out of the rocky face above the river and where it is at the foot of long steep slopes of loose rock, these men going to and fro over their beats in bad weather or ahead of every passenger train, while in fine dry weather they put in some of their time working with the section gang. These men are not taken away from their beats, but do such track work as they can along their beats, either with or without the section gangs. Besides these watchmen there is a special rock gang of 16 men, mostly quarry men, who go over the rock cuts and slopes, etc., and remove any rocks, boulders, etc., which threaten to fall.

Split switches are used and spring rail frogs in main track. Section foremen are required to do their own switch work, which is a much better plan than having a special gang to do this work, as every good foreman should be capable of doing all ordinary switch work, with perhaps the assistance of two or three extra men. A special gang, however, is employed to put in interlocking plants, and it is a somewhat notable feature that all signal and interlocking plant is purchased from the manufacturers, but erected by the company's own employees.

Tile drainage is largely employed in wet cuts, and at the foot of steep side slopes, in which springs occur, the drains being usually a short distance below the ditch, but sometimes as deep as 6 or 7 ft., discharging into culverts. The red, unglazed, collarless tile is used, and a very simple but efficient method has been devised by Mr. Derr for avoiding the usual trouble of the short pipes getting out of position during the tamping and backfilling. A pole 6 or 8 ft. long, and about the same diameter as the bore of the tile, is laid in the trench and the tile strung upon it. The filling is then tamped over the tile, which are held in place by the pole, and the pole is then pulled ahead into the trench (leaving the rear end in the finished drain as a guide) and another row of tile strung upon it. It is also proposed to lay drains of this kind up some of the wet steep side-hill slopes.

The ditching work has been much facilitated by a simple ditching machine devised by Mr. Derr, which consists essentially of a hinged mold board attached to the side of a flat car. The board can be adjusted vertically and horizontally to clear projections, and on open track with standard clearance, the car can be safely run at a speed of about 7 miles per hour. The same machine also trims the ballast slopes quicker and better than the work can be done by hand, leaving a very neat looking track.

Bridges.

There are several bridges on this division, the leading particulars of which are given in the accompanying table.

In addition to the main openings there are about a dozen small water-ways, which were not originally numbered, but are now given fractional numbers for convenience of reference. Many of these small bridges are greater sources of anxiety than the large bridges during wet seasons, being mostly where the line is on a low level at the foot of steep slopes, so that there is very little headway and the rush of water after a storm is liable to choke the opening up with drift and brush unless carefully watched.

Table of Bridges on Delaware Division, N. Y., L. E. & W. R. R.

No of bridge.	No. of tracks.	No. of spans.	Length over all ft.
0	—	1	137
½	2	1	20
1	2	1	108
2	2	5	850
3	HY.	1	70
4	2	1	50 ft. ar.
5	2	1	150
6	2	5	482
7	2	3	122
8	2	4	103
9	2	4	530
10	HY.	1	62
11	3	1	27
12	2	1	22
13	2	5	282
14	2	1	32
14½	2	1	16
15	2	1	24
15¼	2	1	14
15½	2	1	14
16	2	1	54
16¼	3	1	30
16½	3	1	35
16¾	2	1	12
16¼	2	1	16
17	2	1	46
18	2	1	398
19	2	1	105
20	2	1	30
21	HY.	1	66
22	2	2	286
23	2	1	20
24	2	1	150
25	2	4	482
	Honesdale Branch		
26	2	1	28
27	1	1	26
28	1	1	26
29	1	1	112
30	HY.	1	62
31	HY.	1	61
32	1	3	325
33	—	—	—
34	3	2	196
35	1	1	16
36	2	1	16

Nearly all of these openings are spanned by short stumpy plate girders built at the Port Jervis shops from material which would otherwise go for scrap. Some were formerly spanned by two or three I-beams under each rail, but this latter construction, however, is not approved, as it is uncertain just how much of the load each of the beams carries, and the I-beam spans have now all been replaced with plate girders. Of the through truss bridges little need be said, except to call attention to the three different methods of attaching the ends of the floor beams to the posts. The first is the old-fashioned method of straddling an inverted U hanger over the pin, the ends passing through a bearing plate held up by nuts on the threaded ends of the hanger, and the floor beam resting on these plates. In this case everything depends on the threaded ends of the hangers. The second method is an improvement and consists of three or four plates of different length, bored out to fit the main pins and riveted to the vertical end cover plate of the floor beams. The third and best method is to carry the side plates of the post down below the bottom chord and rivet them to the ends of the floor beams, thus avoiding a direct bending strain upon the pins.

Bridge No. 2, over the Delaware River, was built in 1875, by the Watson Mfg. Co., of Paterson, N. J., with post double-intersection trusses, and was erected in 30 days. The spans are 161 ft., 151 ft., 151 ft. and 150 ft. long c. to c. of pins. This is now being replaced by heavier deck-truss steel spans of the single-intersection type, built by the Passaic Rolling Mills, of Paterson, N. J., and having very heavy chords, making a strong and substantial structure which should have but little vibration. In the renewal of this bridge it was decided to facilitate the work by building a single track along the center of a temporary trestle, thus allowing more room for handling the heavy sections of the chords. The two tracks are gantleted across the bridge, and safety in handling the traffic is provided for by working this piece of track as an independent block section on the pilot system, no train being allowed to cross until the pilot-man is riding on the engine, as noted more fully further on.

Bridge No. 13, at Callicoon, is an excellent example of a strong and stiff pin-connected deck truss. It was built in 1892 by the Elmira Bridge Co., of Elmira, N. Y., and the skew is taken out by making each truss with one inclined end post and one vertical end post, the two trusses being placed in reversed position. The chords are exceptionally heavy but the most striking feature of the bridge is the way in which the bracing is applied without connections to the pins. At each panel point four vertical gusset plates connect the posts with the chords, being riveted to the inside plates of the posts, and to these plates are attached the horizontal and vertical diagonal bracing. This we shall illustrate shortly.

On one of the through truss bridges the stone blocks of two of the bridge seats have developed cracks. Both of these blocks have been strengthened by an iron plate on each side, held in place by outside horizontal bolts, the ends of which pass through the end plates, all spaces between the stone and iron casing being filled with cement grout.

The nuts and ends of pins of all pin-connected trusses are painted red and given a white vertical stripe, so that any change of position of the nut or pin can be detected at a glance. The nuts on floor beam hangers are also marked for the same purpose.

The bridge floors are usually of ties 8 ins. × 8 ins. × 9 ft. Outside guard timbers are used, 16¾ ins. from inside of track rail, and iron inside guard rails, 7 ins. clear from the head of the track rail, the guard rails being extended onto the abutments and brought to a point on the approach side of the bridge. A plan which has been proposed by Mr. Derr is to space the ties further apart and lay each rail in an iron trough or channel iron with a clear space of 6½ ins. between each side of the rail head and side of the channel. Where the track is on a uniform curve across the bridge the ties are sometimes sawed to special dimensions, but in general, ordinary ties are used and blocked up to give the required elevation.

The most celebrated structure, on the division is the Starucca viaduct, a handsome masonry viaduct having 17 segmental arch spans of 51 ft. This is one of the finest examples of masonry viaducts in this country, and was described in our issue of Sept. 1, 1888. It was originally built for a single track of 6 ft. gage, and was therefore wide enough for two standard gage tracks when the old Erie R. R. gage of 6 ft. was abandoned. There is no parapet, the top of the ties being level with the broad coping which retains the broken stone ballast. No outside guard timbers are used here, only the inside guard rails, and the rails rest on the Servis ribbed tie-plate. The change from single to double track was made at the suggestion and under the direction of Mr. C. W. Buchholz, M. Am. Soc. C. E., Chief Engineer of the road.

An inspection of the bridges is made every three months by the division superintendent, accompanied by the division road master and bridge inspector, at which times it is decided what general repairs, etc., are required.

In temporary trestling, as at bridge No. 2, no mortise and tenon work is employed, but timbers are butted and fished together and bolted, being thus available again in different structures, while the work of erection is cheaper and more rapid.

Station and Shops.

Port Jervis is the headquarters of the division, and the offices of the superintendent, roadmaster, master mechanic, train master and dispatcher are in the brick station building. The shops of the division are also here, including a machine shop and car repair shop for local work. There is also a roundhouse with ten stalls, and the usual equipment of water tanks, ashpits, coal tipple, etc., for the supply of the engines. The roundhouse floor is covered with fine stone screenings which look unsightly and cause considerable dust. It is expected later, however, to lay brick paving, which will be an improvement. In the machine shop is the "brake instruction school," consisting of a complete equipment of air pump, brake reservoirs, cylinders, connections and brake shoes (and train air whistle) as fitted to an engine and car. There is also a model of the piping of steam heating apparatus. A row of seats is provided, and every Monday afternoon the road foreman of engines gives a lecture on the brake and the method of handling it. The men are not compelled to attend, but find it to their advantage to do so, as in case of any accident or breakdown if it is found that the engineman has not been attending the lectures it is naturally inferred that he has

been more or less careless. The car shops at the time of the writer's visit were very busy changing the grab irons of freight cars to the standard position which becomes compulsory after December.

The ashpit has open sides, with the rails supported by cast iron standards, on stringers, and the ashes are shoveled out or washed out by a water jet onto a platform at the side of a depressed loading track, and thence shoveled into the cars. It is proposed, however, to improve the arrangement by raising the ash track and dumping floor so that the latter will be above the level of the ash cars, and the ashes can be shoveled or washed directly into these cars.

Between Port Jervis and Susquehanna there are 17 stations, the most important being Lackawaxen, Callicoon, Hancock and Deposit.

Painting and whitewashing by compressed air have been tried with success, the former being used for both interior and exterior work, but it is of course necessary to have the paint mixed thinner than when applied by brush. The advantages of this system are the rapidity of the work and the great reduction in cost, while the paint thus applied readily finds its way to joints and narrow spaces almost inaccessible by a brush. For large surfaces, such as walls, etc., it is proposed to try an application of the ball nozzle, and it is also proposed to try the air-painting on cars and bridges.

Coal and Water Stations.

Coaling stations are provided at Port Jervis, Lackawaxen and Susquehanna, at each of which places the coal car track is brought up level with the floor of the tipple, the coal being dumped, and then shoveled into small iron cars which are run out by hand to side loading chutes or overhead chutes. This arrangement involves frequent handling and consequent breakage of the coal. The coal is obtained from Pennsylvania mines, and that supplied for the engines with Wootten fireboxes is often of pretty poor quality, containing a considerable percentage of stone and slate or "bone."

There are water stations at 13 points along the division, the supply being usually obtained by gravity from mountain streams, although in some cases the supply has to be pumped by steam pumps. At Callicoon a Worthington pump forces water to a concrete tank enclosed in a masonry tower, but this tank gives continual trouble from leakage in spite of a new cement lining. No leather hose is used on the end of the spout of the water cranes. The shocks due to sudden shutting off of the water at these cranes are avoided on all of the cranes by the use of a valve operated by the fireman on the tender by means of a hand screw on the end of the spout, so that the valve cannot be closed suddenly. The water tanks are of wood of about 60,000 gallons capacity, and are supported on timber trestle frames.

Block System and Signals.

The entire length of this railway (from New York to Chicago, 986 miles) is operated on the block system, and the Delaware Division is divided into 43 block sections, although at present there are only 32 sections in operation, owing to the closing of some of the towers in consequence of the recent dull times. The arrangement of the block sections is shown in Fig. 1. The block signal equipment was furnished by the Johnson Railroad Signal Co. Each tower has telegraph and bell circuit connection with those of adjacent blocks, and from each are operated the home and distant signal of each track, while in some cases there is an advance starting signal to permit a train to enter a short distance into a block which is clear up to the advance signal, but which may be occupied beyond the advance signal by another train.

The signals are of the standard semaphore pattern, with a red and white blade for the home, and a green and white fishtail blade for the distant signal, these two signals being about 2,200 ft. apart. The lights are red and white for the former and green and white for the latter, and wherever possible the signals are located so that the blades and backlights can be seen from the tower, thus avoiding the use of repeaters or indicators. The ordinary distance of the signals from the tower is 1,500 ft., but some are even 2,800 ft., yet even at this latter distance it has been found entirely practicable to eliminate the compensators without putting any more work on the tower man. The signal posts and towers are painted a dull yellow ochre, a color which does not show up distinctly, and white, as used for the mile posts, crossing signs, mail cranes, etc., would be a much more prominent color.

Both passenger and freight traffic is operated on the absolute block system, and although there was at first some inconvenience in regard to the freight traffic there is now no trouble at all, and everything is found to work more smoothly than under the old system. In case of failure of any of the apparatus, or if the block itself is clear, but the next block is obstructed near the tower, a green flag or light is displayed, and a green card is given to the engineman, notifying him to run under caution in the first case or to look out carefully for signals in the second case.

At the block tower at the entrance to the Port Jervis yard is a fixed red light, and the signalman is forbidden to show the hand green light until a train has slowed down for the red. This effectually prevents fast running through the yard. At the second tower in the yard (the yard being divided into four block sections) there is also a fixed red signal, with a green lamp below, lighted by electricity. This light is switched in by the signalman when notified that the block is clear, but the key is so arranged that he cannot fix it to display the green continually, as may sometimes be done by careless signalmen when a green hand lamp is used. It will be seen that trains are never given a clear signal through the yard, but only the green or caution signal.

Where a middle relief track connects with the crossover connecting the two main tracks, the movements of trains from the relief track are governed by the dwarf signal at the crossover switch. In order to allow of a second train being got clear of the main track when the relief track is occupied, the train may be switched into the opposite main track, a call bell connected with the tower and interlocked with the dwarf signal being used to control the heading out of this train. Similarly, where a train takes an outlying sidetrack on a block section, and the block is thus clear and yet has a train on it, the towerman is notified and gives a following main track train the green signal. In such cases a bell circuit connects the outlying sidetrack with the tower, by which the trainmen can notify the signalman when the train is clear of the main track. The signalmen work twelve-hour shifts, usually from 7 a. m. to 7 p. m. and 7 p. m. to 7 a. m., but they are allowed to arrange the hours to suit their convenience, as in some cases the men go by train to the tower or nearest station.

A novel feature of the discipline on this division, and one which is very worthy of note, is that there is a semi-official recognition of the fact that night signalmen do occasionally go to sleep while on duty. In the event of a man not being fully awake or alive to the situation at the moment he is called on to perform a duty he must take the means to become so before performing it, even at the risk of detaining a train. The endeavor is to teach the men that the safety of the service must be their first thought, under all circumstances.. In effect the superintendent says: "You must not go to sleep if you can help it. But if you do go to sleep and then wake up and see the headlight of a train standing at the tower, you must first go down stairs and find out what train it is, wash your hands and face, or do something to get yourself fully awake before touching the bell key, and you must not touch the signal levers until you have properly communicated with the signalman ahead and been notified by him to send the train on." The quiet and inaction of the signalman's occupation added to the warmth from the stove in winter, naturally induce men to sleep, and if sentinels sleep on duty when the penalty is death it is not to be wondered at that men will go to sleep under less severe discipline, and it is the wisest plan to recognize this. The general plan (as in England) is to threaten a man with discharge and all sorts of punishment if found to have slept on duty, the result being that if the man is waked by a train his first impulse in his half sleepy condition is to pull the levers and send the train on, without waiting to find out how long he has slept or whether the block is clear. In perhaps 99 cases out of 100 this will be all right, but in the hundredth case, he may cause a more or less disastrous collision.

At each signal tower are kept jacks, a wrecking frog and wrecking wedges, the section foremen being responsible for the tools being kept in order.

An interesting case in block working is in force at Bridge No. 2. This bridge is being renewed, and the double track is replaced by a four-rail gantleted single track to facilitate the work of renewing the trusses, the single track extending but little beyond the structure. At the clearance point at each end of the single track a fixed semaphore has been erected, the arm being nailed up at the danger position, thus forming an isolated section in the block section. A pilotman is in charge of this section, and by special order no train must pass the signal unless the pilotman is on the engine. The operation is as follows:

An engineman permitted to pass the signal at tower A knows that the block is clear (the green light is shown but no green card is given, as this section is covered by the special order), but knows by his special order that he has to stop at the fixed signal (a) at the bridge, and if the pilotman is on hand he gets on the train, which proceeds slowly across the bridge to the other fixed signal (b), where the pilotman gets off and the train proceeds at full speed on its own track to the tower B. If the pilotman is not on hand, the engineman waits for him, knowing that the pilotman is probably on a train coming in the opposite direction. By this arrangement there is no special danger in operation, while at the same time traffic is but little delayed, as a train can be sent in each direction between A and B as far as the bridge, where one train must wait for the other. The delay is thus limited to this short section, about 1,200 ft., and trains are

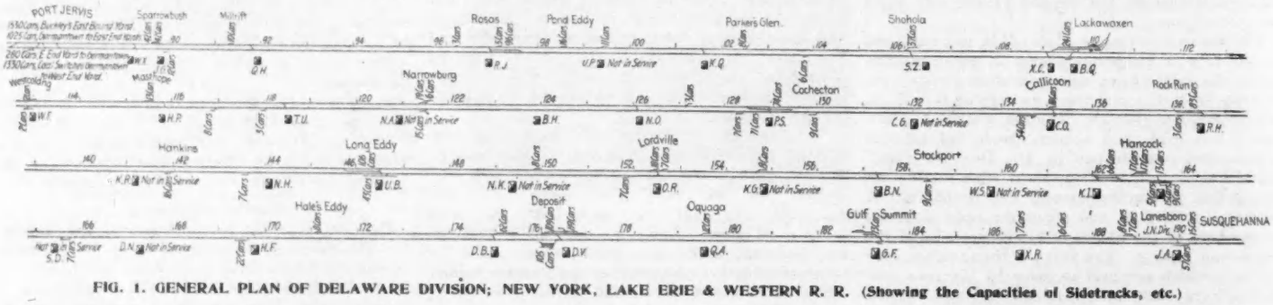


FIG. 1. GENERAL PLAN OF DELAWARE DIVISION; NEW YORK, LAKE ERIE & WESTERN R. R. (Showing the Capacities of Sidetracks, etc.)

run at the usual speed after passing the bridge. In case of two or more trains passing in succession, in the same direction, the pilotman has merely to walk back this short distance to take on the following train.

Sidetracks and Yards.

There are 12 miles of sidetracks on the division, exclusive of yards, and of this total 6 miles are third track for relief sidings, these sidings being preferably placed on the outside of rather than between the main tracks. In place of a derail at sidetracks it is considered that it would be preferable to continue the track to a stub end beyond the switch, so that instead of the damage and delay due to a derailment the cars would merely run out on the stub end, the switch of course being normally open for the stub end. The location and capacity of the sidetracks are shown in Fig. 1.

The only important yard is that at Port Jervis, the plan of which is shown in Fig. 2. The main tracks pass through the middle of the yard. The yard tracks aggregate 42 miles. The receiving yard for eastbound trains has in addition to five receiving tracks a single gravity track (which is shortly to have a second track) with a grade of 1.25% and about 800 feet long, or of sufficient capacity to hold an eastbound train, and at the bottom of this track are seven classification tracks by which cars are sorted for the next division. By this arrangement one man can sort 100 cars per day in station order.

The yard extends from JG to BC block station, a distance of 2.9 miles, and will hold 4,200 cars. All connections with the main tracks are at block stations, so that these tracks can be fouled only at such points as are protected by block signals. Eastbound freight trains generally enter the yard at JG station, and are left there for classification. The three tracks nearest the main tracks in the eastbound yard are also "receiving" tracks, being used for that purpose when those at JG are filled. In this case the trains enter the yard at WX block station. The caboose is cut off at JG or WX, as the case may be, and allowed to run down the main track by gravity to a caboose siding. The cars are classified in the "eastbound" yard, and thence taken in solid trains by yard engines to the "eastbound advance" yard (see Fig. 2), whence they are taken by road power to leave the yard at BC station. The local cars are switched out and set on the four available tracks west of the "gravity yard," after which they are placed on the two "gravity" tracks, which hold a maximum train. From there they are run by gravity onto "classification" tracks at the foot of the "gravity" tracks, which latter have a grade of 1.25%. Westbound freight trains enter the yard at block station PA. The cabooses are cut off about 1,000 ft. east of station BC, and drop by gravity into the "eastbound advance" yard, whence they are taken as required by eastbound trains. The general operation of the "westbound" yard is about the same as that of the "eastbound," except that there are no gravity tracks. The track next to the main track, and the one on the extreme outside of this yard are kept open, to facilitate the movement of engines to and from the coal pockets. Westbound trains leave the yard at station WX.

The arrangement of the yard is fairly satisfactory, but like most yards in this country it has been developed from time to time without any special arrangement in view, the main idea in enlarging yards being usually to provide more tracks for cars to stand on. As a matter of fact, however, yards are not intended for storing cars, except incidentally, and the quicker the cars are passed through and sent on the better. Classification yards should, however, always have spare tracks to receive a set of cars when one of the classification tracks is full, as the blocking of any one track in such a yard blocks the entire yard. Yard work will be much facilitated when it becomes general practice to put the cars of a train in station order, or at least in division order, and the former practice is followed out for local freight trains on this division. When a through freight on the latter plan arrives at a divisional yard one switch engine can at once take off from the rear the cut of cars for that point, while another switch engine at the head of the train is hauling the rest of the train to the classification tracks or beginning to switch the cars.

The tracks for fast freight should be at the upper end of the yard, as the fast freight trains always go out ahead of the local freights, and should not interfere with the switching of the latter.

Pole switching is employed only when the yard is busy, handling 4,000 to 5,000 cars per day and requiring a crew of at least twelve men, but it is not considered economical for ordinary or light work with about 400 to 500 cars per day. The objections made to tail switching on account of damage to cars, can be eliminated by proper discipline and a strict investigation of all such cases of damage.

A difficulty experienced here, as in most yards, is that of keeping the surface of the yard neat and free from weeds. The yard gangs have other and more important work to attend to and have little time to give to this incidental work, with the result that the surface gets irregular, and weeds grow thickly on little used tracks, making the general appearance of the yard unsightly. A machine that could be used for such work would be a welcome addition to the equipment of a yard section gang.

Train Service.

The standard number of loaded cars for westbound freight trains is 50 for a ten-wheel engine and 45 for a consolidation engine, or 75 and 65 cars for eastbound trains. Coal trains haul 85 cars between Honesdale and Port Jervis. Car rating is, however, not the proper way to estimate train loads, some of the so called "loaded" cars being practically empty. It is much to be desired that some system of rating freight train loads on a tonnage basis should be introduced, but this cannot well be done without the active cooperation of the freight department. On this division a tentative introduction of such a system has been made on a small scale and with satisfactory results.

Another important innovation is the arranging of cars in order of divisions for through trains and in order of stations for local trains, so that all the sorting switching is done in the divisional yards by a large and experienced crew, and not by the trainmen on the limited sidetrack room of a way station. With a local freight train thus sorted (and the cars for the first station at the head of the train) the first cut of cars is uncoupled at each station, the engine then hauling the cars ahead, putting them on the sidetrack and returning to the train. Not only does this facilitate freight traffic and train movements, but the enginemen have much less objection to being assigned to the local freight trains than if they are likely to have to perform a number of switching movements at every station, as is usually the case with the haphazard system of making up trains.

There is comparatively little trouble from freight trains parting, this trouble having been materially reduced by taking out a number of sags in the grade line.

The number of passenger trains each way is

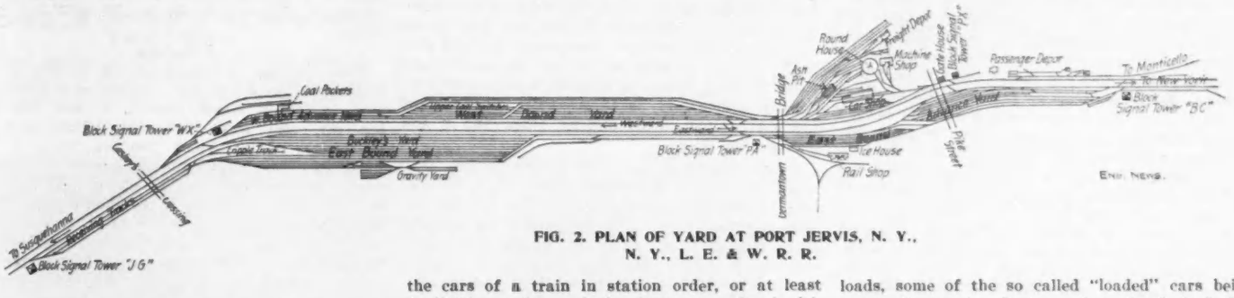


FIG. 2. PLAN OF YARD AT PORT JERVIS, N. Y., N. Y., L. E. & W. R. R.

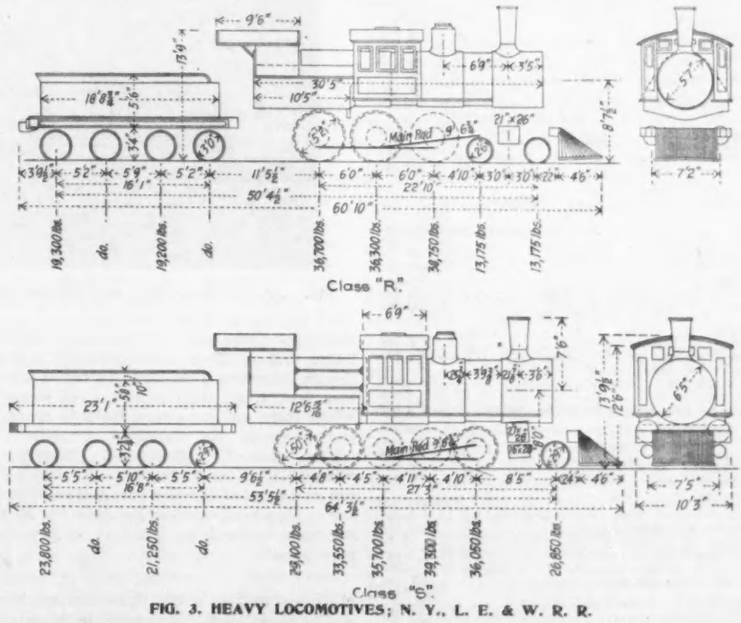


FIG. 3. HEAVY LOCOMOTIVES; N. Y., L. E. & W. R. R.

about 12 in summer and 10 in winter, while the number of freight trains (including second sections) is about 20 in summer and 30 in winter. Passenger train service includes a milk train for New York.

Locomotives.

The bulk of the traffic is handled by engines of the ten-wheel and consolidation types, the former being used on both freight and passenger service. Some of the light and local trains are hauled by engines of the eight-wheel type, while six-wheel switch engines with eight-wheel swallowtail tenders are used in the yards. The ten-wheel engines are fine and powerful machines, and the majority have Wootten fireboxes. As usual with such engines the cab is at the forward end of the firebox. There is also a fairly comfortable cab over the rear end of the firebox, the hood of which extends beyond the firebox, and is provided with canvas side curtains, so that the fireman is not entirely without shelter as on the Philadelphia & Reading R. R. It would seem entirely practicable to have a footboard at the back of the firebox protected at the sides by the cab, instead of having the fireman stationed on the tender deck. The equipment of this division includes also six enormous Baldwin four-cylinder decapod engines used as pushers for freight and coal trains on the grade from Susquehanna to the summit. These engines have cylinders 16 × 28 and 27 × 28 inches, driving wheels 4 ft. 2 ins. diameter, and weigh 192,500 lbs. One of these immense engines was exhibited at the Columbian Exhibition, and was illustrated in our issue of June 15, 1893. The locomotive equipment of this division consists of about 10 eight-wheel engines, 17 ten-wheel engines, 40 consolidation engines, 4 six-wheel switchers and 6 decapod pushers. The leading dimensions of the large ten-wheel engines of Class R (used for both passenger and freight trains) are given in the accompanying table, and these engines as well as the decapod pushers are shown in Fig. 3.

Ten-Wheel Locomotives; Erie R. R.

Running Gear.	
Driving wheels, diam.	62 ins.
Truck wheels, diam	30 ins.
Tender wheels, diam.	36 ins.
Engine truck	Swing center.
Wheel Base.—Driving	12 ft. 0 ins.
Truck	6 ft. 0 ins.
Total engine	22 ft. 10 ins.
Tender trucks	5 ft. 2 ins.
Total tender	16 ft. 1 in.
Total engine and tender	50 ft. 4½ ins.
Center of truck pin to center of leading driver	7 ft. 10 ins.
No. and order of wheels having blind tires	Midddle drivers.
Length over all	60 ft. 10 ins.
Weight in Working Order:	
On drivers, 38,750, 36,300 and 36,700	111,750 lbs.
On truck	26,350 lbs.
Engine, total	138,100 lbs.
Tender, total	80,878 lbs.
Engine and tender, loaded	218,978 lbs.
Tender, empty	52,800 lbs.
Of full coal capacity	9 tons.
Of full water capacity of tank	30,078 lbs.
Allowed for water in boiler	11,150 lbs.
Cylinders.	
Distance center to center	7 ft. 2 ins.
Distance center to valve face	18¼ ins.
Piston rod, diam.	3½ ins.
Form of guides	Two-bar.
Crossheads	13 ins. deep.
Connecting rod, length between centers	9 ft. 6¾ ins.
Valve Gear—Type	Link motion.
Ports, steam	1¾ × 19 ins.
Ports, exhaust	2¾ × 19 ins.
Slide valves, max. travel	6 ins.
Slide valves, lap., 1 in.; lead	1-16 ins.
Boiler.—Type	Straight-top
Diam. of barrel inside (first course)	5 ft. 4⅞ ins.
Thickness of barrel plates	9-16 ins.
Thickness of smokebox tube plate	½ in.
Height from rail to center line	8 ft. 7½ ins.
Length of smokebox	15 ft. 4¾ ins.
Working steam pressure	160 lbs.
Firebox.—Type	Wootten.
Length inside	9 ft. 5 13-16 ins.
Width inside	8 ft. 2⅛ ins.
Depth at front	4 ft. 1½ ins.
Depth at back	4 ft. 10½ ins.
Thickness of side plates	5-16 ins.
Thickness of back plate	5-16 ins.
Thickness of crown sheet	⅜ ins.
Thickness of tube sheet	½ in.
Grate area	77.55 sq. ft.
Stayboits, diam., 1 in.; pitch, side sheets, 4 ins. horizontally, 4½ in. vertically.	
Water space, width	3½ ins.
Tubes.—Number	258
Diam. outside	2 ins.
Length between tube plates	10 ft. 10 ins.
Total fire area of tube openings	4.3 sq. ft.
Heating Surface.	
Tubes, exterior	1,480 sq. ft.
Firebox	156⅓ sq. ft.
Combustion chamber	62⅓ sq. ft.
Total	1,699 sq. ft.
Miscellaneous.	
Exhaust nozzle, diam.	3½ ins.
Smokestack, smallest diam.	15¾ ins.
Smokestack, height from rail to top	15 ft. 11 ins.
Capacity of tank	3,600 gal.
Capacity of coal space	8 to 9 tons.
Brake fittings, Westinghouse air brake; American driver brake.	

The use of painted instead of planished iron for locomotive jackets has been tried, and a number of old engines which have been sent to the shops have had the planished iron jackets on the boiler and Wootten firebox painted black, the same as the cab, frames and wheels. The result may be said to be entirely satisfactory as to appearance, and there is every reason to suppose that they will be equally satisfactory as to economy. The engines are not painted at the division shops but at the Jersey City shops.

A matter much discussed by railway men is that of the amount of emergency equipment to be carried on the locomotives, and on this division the equipment so carried is kept as small as possible. Thus, instead of equipping each engine with jacks, wrecking frogs, etc., there are placed at each block tower a set of jacks, wrecking frogs and wedges, and these tools are in charge of the section foremen who must see that they are kept in proper condition for service and returned to place after use. Each passenger engine, however, is provided with a wrecking frog and wrecking wedge. A similar practice is followed in regard to lamps used as markers on light engines. It is comparatively rare that an engine is run light, or without a train, and if each engine carries these lamps they are likely to be damaged or broken although not used. The lamps for markers are therefore kept at all stations and at all signal towers where there are crossovers, being in charge of the station agents and signalmen respectively.

The Baldwin double-end express engine "Columbia" (Eng. News, June 5, 1893,) has been run at a speed of 74 miles per hour on this division, and a six-wheel switcher has been run at 45 miles per hour without being found very unsteady at such speed.

Cars.

All cars that go to the shops now are having the grabirons or handholds changed to the standard position, as such position is made compulsory by law after December. At the same time the height of coupler is, if necessary, changed to the standard.

The older cabooses for freight trains are very short, but all new cabooses are made longer although mounted on four wheels only. The cabooses are painted red, but Mr. Derr considers that only the ends should be painted red, the use of this color being as limited as possible, so that when it is seen by an engineman it will at once attract his attention as meaning danger. Nearly every road has a rule forbidding trackmen to wear red shirts when at work, as being likely to be mistaken for a danger signal or to lead to carelessness in observing a red danger flag, and there seems to be no reason why the object of this rule should not be observed in other departments of service.

The coal cars are kept in constant and rapid service. Those loaded at the mines at Honesdale in the afternoon get to Port Jervis between 8 p. m. and 2 a. m., and to New York in the morning in time to be unloaded and sent back empty in the afternoon. There are also special milk and fruit trains.

Wrecking.

The wrecking equipment on the division is stationed at Port Jervis and consists of a hand derrick, a 25-ton steam derrick, a tool and living car, and three flat cars. This train is in charge of a wreck foreman, who is always in the neighborhood during the day, while another man is in charge of the tools and sees that everything is returned to place after use. Car shop men form the wrecking gang, and at a wreck the work is in entire charge of the wreck foreman, who alone is responsible for the proper conduct of the work. By day a bell signal calls the wrecking gang to the train, and by night there is a system of callers, certain men being called and in their turn, calling others. It is proposed to put electric call bells in the houses of some of the wrecking gang, thus saving considerable time in getting the train out. Any engine may be taken, and if necessary a train engine may be taken, but as a rule there are always engines under steam in the roundhouse or yard. The train is fitted with a fire equipment for use at fires at wrecks, shops or other buildings, or at towns along the line. Different kinds of patent wrecking frogs are used, but none are considered superior to the old fashioned wrecking frog and wedge. An abstract of a paper by Mr. Derr on wrecking and wrecking trains was published in our issue of March 14, 1895.

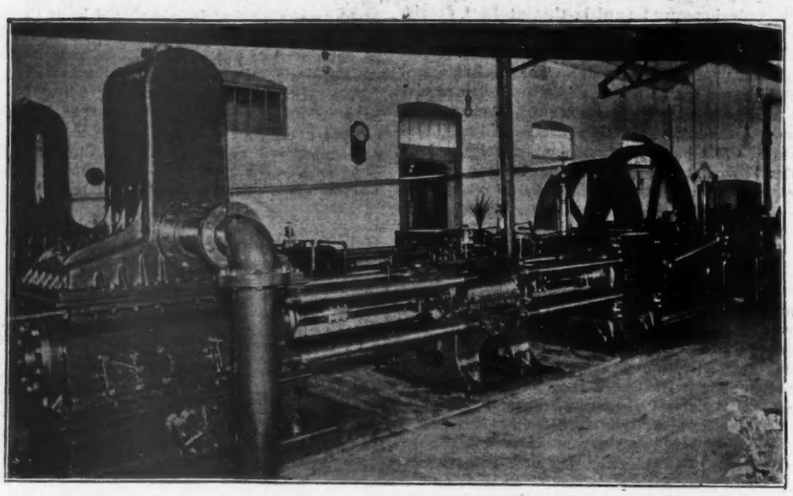


FIG. 1. A COMBINED AIR COMPRESSOR AND WATER PUMP FOR THE OCEAN GROVE WATER-WORKS.

Employees.

The employees on this division include approximately 450 trackmen, 80 switch and yard men, 160 freight brakemen and flagmen, 40 freight conductors, 50 passenger brakemen, 20 passenger conductors, 160 freight enginemen and firemen, 75 passenger enginemen and firemen, and 375 shopmen.

The sectionmen are largely natives. The best men from whom to recruit the force of trainmen are young men living along the line of the road and who have not previously been in railway employ. This is the system recommended in the report of the committee on "The Relations of Railway Companies with their Employees," presented at a recent meeting of the Am. Soc. Railroad Supts. (Eng. News, Oct. 17, 1895). In regard to the disciplining and punishment of employees, Mr.

Derr prefers the present system of punishing by private reprimand and suspension to that by demerit and announcements posted up on a bulletin. This latter system, which aims to shame men by public reprimand, would, he considers, be cared for only by the good men, who are ordinarily careful, but would be laughed at and taken as a joke by the careless and worse men.

Some remarks on railway division superintendents and their work will be found in our editorial columns.

THE POHLE AIR LIFT PUMP AT THE OCEAN GROVE WATER-WORKS.

A novel feature of the air lift pumping plant at Ocean Grove, N. J., is the direct connection of the air cylinders for the lift pump, and the water cylinders of the main pump to the cylinders of the steam engine. This is accomplished by extending the piston rods through the back heads of the engine cylinders, and through the air cylinders to the water cylinders beyond. The air and pump cylinders are in duplicate, and are connected to a pair of Corliss engines. The air cylinders are 18¼ ins. in diameter and of 30-in. stroke.

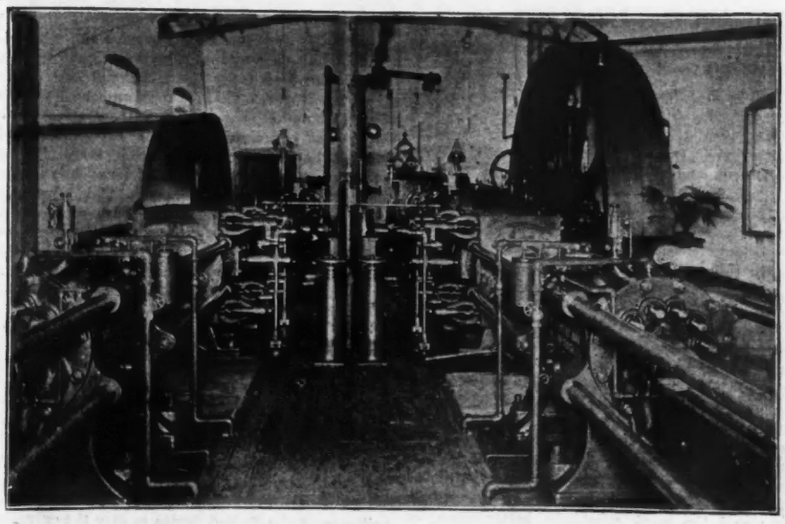


FIG. 2. AIR CYLINDERS FOR POHLE AIR LIFT PUMP, OCEAN GROVE WATER-WORKS.

The water supply is from some 20 driven wells, 400 to 600 ft. deep, cased to 4 and 6 ins. inside diameter. The compressed air lifts the water to tanks, from which it is forced by the regular pumps to a stand-pipe. The available supply is said to be 2,500,000 gallons a day. It is said that deep well pumps gave much trouble through clogging, the water coming from a stratum of quicksand. Aside from clogging the deep well pumps in use did not yield a sufficient supply of water. No other source than deep wells seemed available. An electric lighting plant is operated in connection with the pumping plant, all being operated as one station by the Ocean Grove Asociation.

ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION.

The ninth annual report of the Interstate Commerce Commission commences by considering the means necessary to make effective and give force to the law in accordance with the purposes of its enactment. The original Act needs amendment in the light of obstacles developed in the attempts to enforce it in the past few years. In several cases the courts have held that the Act was unconstitutional in requiring testimony which would tend to incriminate the witness; the government could not appeal and the request of the Commission to Congress to amend the Act so as to allow the government to appeal to the Supreme Court has been so far without result.

The Commission again asks for this relief and points out the amendment desired, confining its recommendations within the limits and aims of the original act. The special weakness of the law is the want of finality and binding force in the decisions of the Commission. Under the statute, as judicially interpreted, the carrier can not only have a new trial of the same question in the courts, but the court may be required to pass upon a very different state of facts from those presented to the Commission. It is now asked that the decisions of the Commission be made to stand as a rule of conduct prescribed by public authority, unless the courts, upon examination of the record thus made, shall find some material error, plainly prejudicial to the defeated party and furnishing sufficient reasons for refusing to enforce that decision. The Commission properly has no power to convict for or to punish misdemeanor under the Act. But the tendency towards railway consolidation is very marked and indicates future combinations wielding such extraordinary power, as to constitute, in the estimation of many people, a menace to commercial freedom. The commission believes that this power would be shorn of its chief danger if the authority of the State to prevent excesses and inequalities were backed by enforceable methods of fixing standards of rates. When charges are made that rates are excessive or relatively unjust, the charges should be investigated on full notice and a fair hearing given to the carriers; but then the determination of the Commission should be final and binding upon all parties and fix the only lawful rates in the controversy in question, except in the case of material errors mentioned above.

Among other recommendations, the law should be amended to make tariffs and annual reports on file with the Commission competent evidence and self-provable as prima facie what they purport to be for the purpose of investigations by the Commission, and in all judicial proceedings. It would be also necessary to fix the date within which annual reports should be filed with the Commission, with a penalty for noncompliance. The Commission does not advise the abolition of the imprisonment feature in the penal provisions of the law.

After detailing the work of the Commission in the last year, the report condemns "the separate and independent line theory," which denies comparison of aggregate or total charges in cases under the Act. It is contended that the word "line" in the Act means a physical line and not a mere business arrangement and carriers are prohibited from charging through rates on traffic over a line formed by connection of two or more roads which are less as a whole than rates in force on like traffic, carried under similar conditions, in the same direction over either of the separate roads of the "line."

The statistics of railways, for the year ending June 30, 1894, have already been given in our issue of Oct. 31, 1895. The provisions of the Safety Appliance Act of March 2, 1893, became operative on July 1, 1895, so far as they related to grab-irons on cars and the standard height of draw-bars. It was apparent in due time that a large number of cars had not been provided with the appliances required and many applications came in for an extension of time. Finally, the Commission did extend the time for the placing of grab-irons, to Dec. 1, 1895, and for such time only, and after Feb. 15, 1896, carriers are prohibited from using any car not provided with draw-bars of the prescribed standard height.

The carriers are apparently endeavoring to comply with the law. Owing to some question as to the authority of the American Railway Association, an association of individuals, to fix the standard height of draw-bars, it is suggested that the standard which has been in operation since July, 1893, be definitely authorized by Congress. The great object to be obtained in grab-irons and in draw-bar height is uniformity.

Under the head of traffic agreements the report mentions and discusses the pooling of freights and division of earnings. The Commission concludes that the agreement of the Central Traffic Association, of May 1, 1894, for the division of eastbound dead freight, dressed meats and live stock from Chicago, is virtually a pooling agreement and that the contract violates the 5th section of the Act. They have requested the U. S. Attorney General to institute and prosecute necessary proceedings for the punishment of such violations. As regards the pending contract between the principal railways connecting Chicago with the Atlantic seaboard, the Commission does not consider that it is justified in taking any steps until it has some evidence that under the cover of an agreement the law is in fact being violated by its operation. Under the restrictions suggested, pooling would be permitted; provided that the corporations so privileged submit themselves to the only legal authority which can prevent an abuse of the privilege.

Ticket-brokerage is roundly condemned as being without a legitimate field, and essentially lawless. The Commission asks for authority to make examinations by special agents under its own directions; and the subject of uniform classification is again referred to as being absolutely necessary for the purposes of the Act, and no further relief need be expected in this direction from the voluntary action of railway managers.

The method of preventing electric street railway accidents adopted by the Steinway Electric Ry. of Long Island City, N. Y., is worthy of adoption by trolley and cable car lines in general. In accordance with an agreement made a year ago, prizes of $25 each were paid each motorman and conductor who got through the year without an accident to his car. The full prize was given to 98 men, and lesser prizes were given to 94 men who had served less than a year, over $4,000 in all being distributed.

"Steel Pipes a Failure" is the displayed headline of an utterly erroneous article in the Pittsburg "Labor Tribune" of Jan. 2, published in the Pittsburg "Leader" of an earlier date, to the effect that the National Tube Works Co. was about to abandon the manufacture of steel pipe at its works in McKeesport, Pa., and to go back to making wrought iron pipe, because it "has discovered that the making of pipe from steel is not a success." Disbelieving the report, especially as one of the staff of the Engineering News, during a recent visit to the works at McKeesport had found them excessively busy making steel pipe, and running blast furnace and Bessemer works to supply the steel, we wrote to the company for information, and have a reply to the effect that the article in the Pittsburg paper is a libel pure and simple, that the manufacture of steel pipe is a perfect success, between 400,000 and 500,000 tons having been made during the past three years. The company also makes wrought iron pipe as it has always done, but 95 tons of steel pipe are called for where 5 are specified to be wrought iron.

The contract for building battleships Nos. 5 and 6 was awarded, on Dec. 28, to the Newport News Shipbuilding Co. at its bid of $2,250,000 for building each ship on Department plans.

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The committee appointed by the Aldermen of Somerville, Mass., to investigate the charges brought against the late City Engineer, Mr. Horace L. Eaton, in its two reports, completely exonerates the memory of that overworked, but faithful official. Alderman Downs originally charged corruption in connection with some sewer work, and working for private parties in a city office and on time paid for by the city. The searching investigation which has followed shows conclusively that the corruption did not exist; and while Mr. Eaton did at one time do work for outside parties, such work was done outside of office hours and in time that was his own. In February, 1894, the Committee on City Engineering passed a resolution forbidding the City Engineer to work for individuals, and the investigating committee fails to find any evidence that Mr. Eaton performed any work contrary to this resolution. The committee concludes by saying, in both reports, that it has been unable to find any proofs of corruption, dishonesty or unfaithfulness to duty in the conduct of the late City Engineer, and the only testimony in favor of such charges was, in the minds of the committee, so biased and prejudiced as to be unworthy of credence.

Both majority and minority reports roundly condemn the too prevalent freedom with which some citizens and members of the city government attack the personal integrity of officers, especially, when such attacks have no other excuse than a desire to see some one else in the same office. In this case a conscientious, hardworking and competent engineer was scandalously and unmercifully treated by a few dissatisfied persons and a jealous employee; with the sad result, that under the strain of overwork and the shock produced upon a too-sensitive mind by the injustice of the charges, he took his own life.. It is to be hoped that the experience of the Somerville accusers and accused may be of benefit in other cities. The public officers of a city are the guardians of its honor and interests; they speak with a certain authority and their utterances, especially if sensational, are eagerly seized by the press and spread broadcast over the country. Under any circumstances, the publication of damaging charges against an official, based upon careless, unsupported or biased evidence, cannot be too severely denounced, as unjust to the accused man and as prejudicial to the good name and best interests of the city. But, as says one of the committees in its report, this lesson is impressed upon us with startling force when the tragical results at Somerville are considered. The testimony before the committee practically proved that the controlling animus in this case was the intention on the part of certain persons, to cause Mr. Eaton to be ejected from his office of City Engineer. Notwithstanding the fact that he had devoted the best years of his life to the interests of the city and had been "one of its hardest working and hardest worked employees," the conspirators maliciously and falsely held him up before the community as a wrong-doer. There is another lesson in the evidence that applies to more cities than Somerville, and that is, that the work imposed upon Mr. Eaton as City Engineer had previously taxed his mental and nervous strength to the utmost; and that to the effect of this overwork, quite as much as to the false charges made the loss of his life must be ascribed. There is a limit to human endurance, even in a City Engineer; and it is both unwise and unjust, under the cloak of enforced economy to expect to receive the work of several competent men for the pay of one.

An effort is being made in Chicago to reduce expenses in the city government by consolidating city departments; and the first reform proposed in this direction is the formation of a single Bureau of Inspection, under one responsible head, combining the now four separate departments of inspectors of gas, oil, weights and measures and steam boilers. Those who advocate this single bureau claim that more efficient service will be secured and an annual saving in salaries of $100,000 will be made. This is a reform which could be adopted with profit in many other cities besides Chicago. As a rule, our cities are burdened with a multiplicity of "heads of departments"; offices created purely as rewards for party service; rewards which the citizens pay. This practice is not only wasteful of public money in the relatively high salaries paid, but it also seriously interferes with the proper and economical conduct of city work by breeding petty jealousies and placing too many masters in charge of one job. There is no necessity for many of these offices, for the real work is done by subordinates; and the work would be better done by making these subordinates directly responsible under some one efficient manager. This consolidation of responsibility especially applies to the engineering duties of a city government, now too often split up among a half dozen separate and independent departments. This centralization of engineering control is the rule in Continental cities and has been tried with success in several American cities. In the Chicago case mentioned there is certainly no necessity for the separate existence of the bureaus referred to above, except for the fat offices thus provided; and if every American city were to take a careful and honest account of its stock of offices, from the standpoint of more efficient and economical administration, the saving that could be effected would probably astonish the investigators. It should be remembered, however, that it is bad economy to expect one man to properly do the work of six in attempting reform of this character. The object should rather be to reduce the number of separate departments and to concentrate authority under competent and well-paid men, and these men should have all necessary assistants, of their own selection, to properly perform the duties of the office. The saving comes in in more satisfactory, prompt and economical work, and in lopping off the large salaries paid to officials who do no real work.

The pig iron industry is now in a remarkable condition. After a short lived boom, in which the price of Bessemer Pig, at Pittsburg, advanced from $10 in March to $17 in September, the price fell more rapidly than it had risen, and the market closed on Dec. 31st, with exceeding dullness and quotations from $10.75 to $11. In April, 1895, when there was no reason to expect a boom, an event that startled the trade was the voluntary advance of 15% in wages to the coke workers of The Frick Coke Co., a concern which controls about two-thirds of the coke production of the Connellsville district, from which nearly all the furnaces north of the Ohio river obtain their coke. The advance in wages apparently without cause, immediately increased the cost of making iron. Before the advance, coke sold at the ovens at about 90 cts. per ton. After the advance it sold at from $1.25 to $1.35, advancing to as high as $1.60 in October; another advance in wages of the workers of about 6% being reported. The year closes with extreme dullness in the pig iron market. Prices of iron are declining, and production having greatly increased since September, is now ahead of consumption and stocks unsold are increasing. In the face of this condition one might expect to hear that wages of the coke workers would be cut down, but instead of this another voluntary advance of 10 to 15% is made by the Frick Coke Co., making the wages the highest ever known in the coke regions, and it is also announced that the price of that company's coke for 1896 will be $2.00 per ton, or more than double the price that it was a year ago. Will the company which controls two-thirds of the whole output be able to maintain this price, is now the question which puzzles the whole iron trade. If it does maintain it, the price of iron must be advanced to cover the additional cost of coke, the wage workers will be happy and the Frick Coke Co. will make enormous profits. Capital is certainly not oppressing labor in this instance, but it will be interesting to watch what the poor coke consumers, the owners of blast furnaces outside of the Carnegie Steel Co., which practically controls the Frick Co., are going to do about it. Their position between the millstones of advancing prices of coke and declining prices of pig iron is not an enviable one.

The short paper on locomotive service by Mr. J. H. McConnell which is abstracted on another page of this issue is deserving of careful attention for the warning which it calls out against the temptation to the motive power official to subordinate the freight train load to the fuel and repair account of his locomotives. As Mr. McConnell well says, a freight locomotive should be made to haul every ton of freight it is capable of hauling regardless of cost for repairs and fuel. It is perhaps this one thing which more than any other has enabled the railways of the United States to give the extraordinarily low freight rates, compared with those of foreign countries, which the American shipper enjoys. To subordinate the coal and repair expense to the heavy train load has come to be the distinguishing principle of railway operation peculiar to American railway practice. While there is little danger that American railway managers will go back on this principle, there is always a danger that the mechanical department, particularly if it does not keep in close relation with the operating department, will gradually lose sight of it and devote its attention to increasing the locomotive mileage and reducing fuel expenses until low repair and fuel accounts come to be regarded as the great goal of its efforts. Mr. McConnell as a motive power official has done a good thing in calling the attention of those in charge of railway machinery to the fallacy of such ideas, and in showing from his own experience how the results he urges can be attained.

It is somewhat interesting to trace the evolution in the form, bulk and convenience for use of books devoted to technical subjects, which has taken place within the last half century. Following the fashion of their day, the earlier writers upon engineering matters issued their works in folio volumes, printed on heavy paper, with wide margins, large type and costly copper-plate engravings, too often folded even in the ample page provided. They were very expensive and very clumsy to use, and the only excuse for their being was that books upon this subject were rare, and the would-be user was compelled by circumstances to pay the price and to submit to the unhandy form of the volumes. But as engineering knowledge and experience expanded and the number of engineers increased, the demand for works upon this subject also grew, and this demand compelled a reduction both in bulk and in price. The establishment of technical schools made text books necessary, and this necessity, perhaps more than anything else, called for the convenience in form which is being recognized. So far as engineering literature is con-

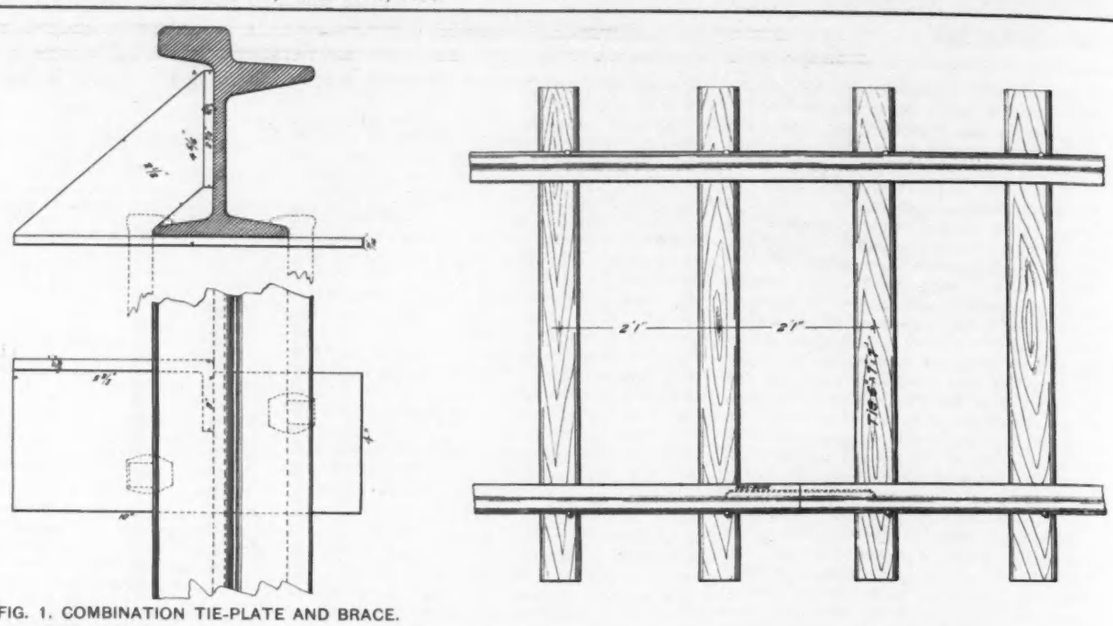


FIG. 1. COMBINATION TIE-PLATE AND BRACE.

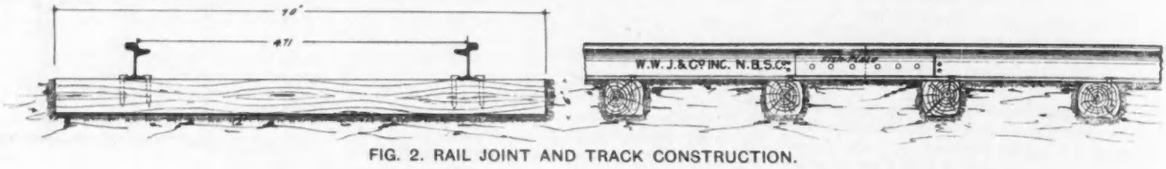


FIG. 2. RAIL JOINT AND TRACK CONSTRUCTION.

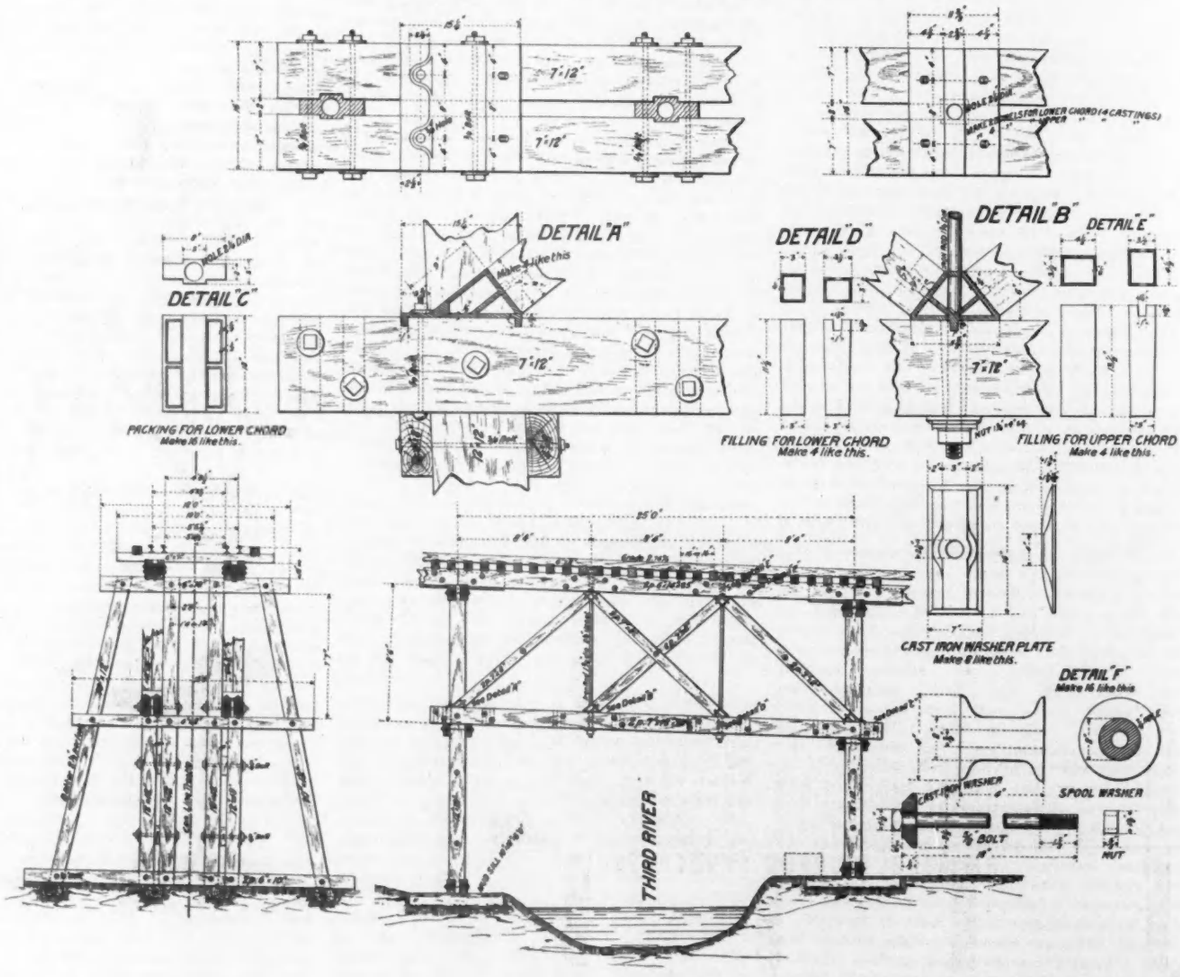


FIG. 9. DETAILS OF TRESTLE

PASSAIC & NEWARK ELECTRIC RAILWAY; Passaic & Newa

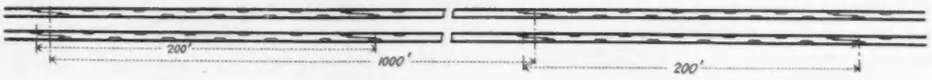


FIG. 5. BONDING OF TRACK.

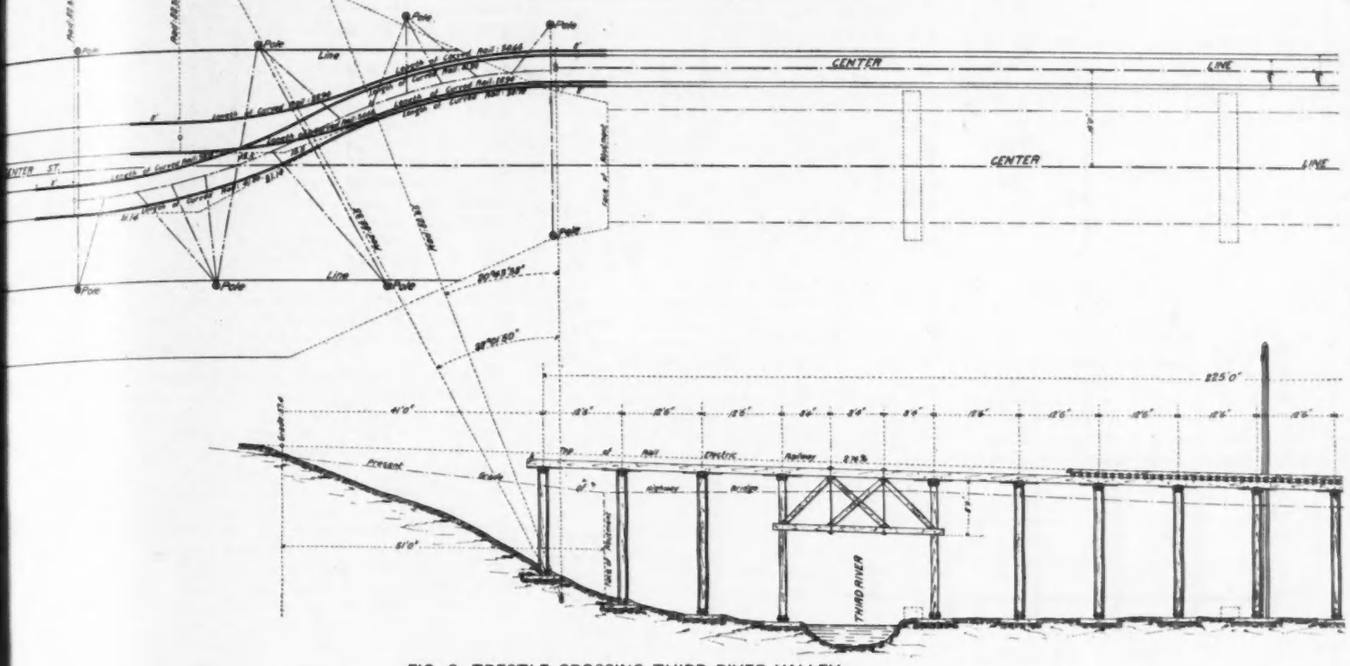
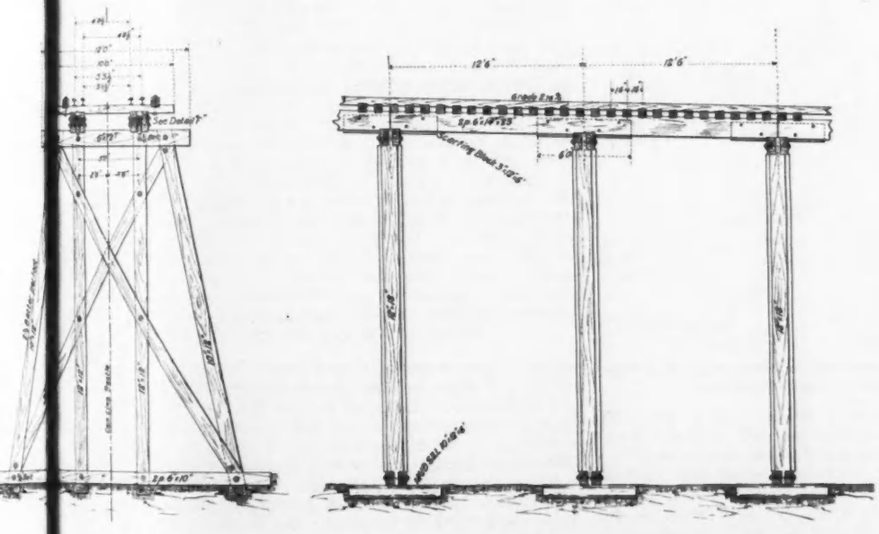
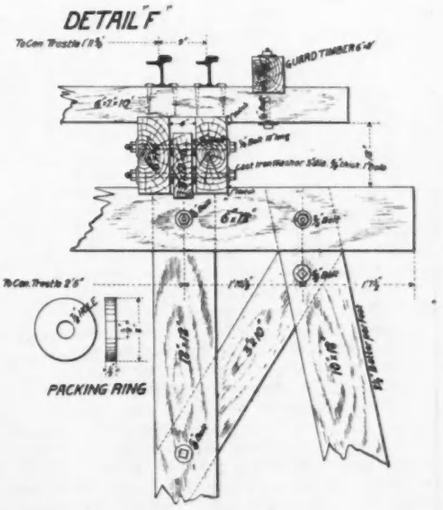
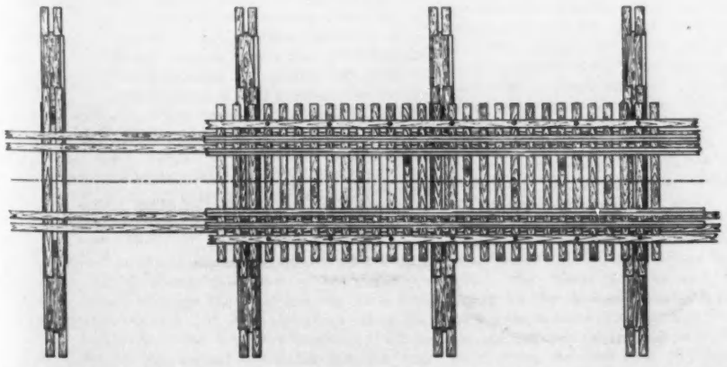


FIG. 8. TRESTLE CROSSING THIRD RIVER VALLEY.







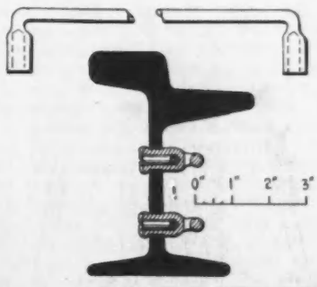


FIG. 4. RAIL BONDS.

LS OF TRESTLE CONSTRUCTION.

saic & Newark Electric Traction Co. Engineers, Wise & Watson.

cerned, the large folio volume has now disappeared; or is only used in special reports which seem to still demand an unusual expanse of page for maps and illustrative work. But that there is room for improvement in the size of text-books, even, at this late date, is made evident by two volumes now before us. These are two editions of Prof. J. B. Johnson's "Theory and Practice of Surveying"; both published by John Wiley & Sons, in 1895, and both containing exactly the same matter and issued at the same price. But one book measures 9½ × 6½ in. by 1½ in. thick, and the other 8¼ × 5⅞ in. by 1¼ in. thick, the difference in weight is 10 ounces. But more than all else, one is a handy volume that might be slipped into a coat-pocket in an emergency, and the other is a bulky, heavy volume that can only be used in the office library. This improvement is made possible, while employing exactly the same stereotype plates, by the use of thinner but excellent paper, and by trimming the margins down to a size that is really more symmetrical and pleasing to the eye than the margins in the older editions.

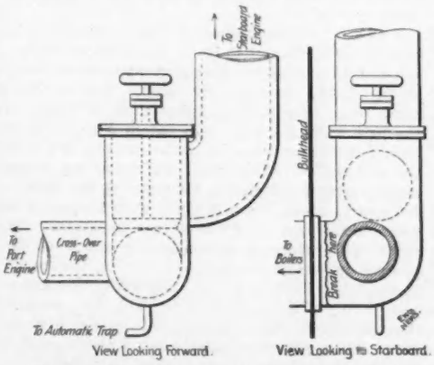
We congratulate the publishers upon recognizing what is an actual demand in books of this character. Engineers and engineering students belong to a very practical class as a rule; and they are more interested in the contents of their books than in width of margins and bulk of volumes. More, perhaps, than any other class of professional men, engineers require convenience and a minimum of bulk in their working libraries; for they have to move them oftener, and in transportation bulk and weight count rapidly and adversely. It may also be said that oblong folios and unusually high octavos are a nuisance in any library; and they are especially so in an engineer's library. There is little, if any, excuse for them; and a proper arrangement of text and illustration will usually remove all necessity for volumes of these objectionable dimensions. Unfortunately, books are issued by authors and publishers which need "padding," and unnecessary width of page and margins, large type and loaded paper are supposed to make up for deficient subject matter, or value in the text. This is a fraud upon the purchaser that must sooner or later react upon both author and publisher, and it is one that cannot be too soon suppressed. If the text is of real value and worth publishing at all, the purchaser of technical literature wants it in the handiest and most convenient form for use, with the least bulk possible, and at the least cost for which clear type, good paper and good press work can be furnished. In fact, at the same price, the busy engineer will always select the handier volume; and this is a pointer that the wise publisher of technical literature will heed—and profit by.

At a time when so many competent civil engineers and their assistants are seeking work, it is of interest to note that in the recent examinations for positions in the New York State Engineers' service, over a third of the candidates failed to secure the required percentage so as to be placed on the eligible list. State Engineer Adams reports that of 31 men examined for the position of assistant engineers only 19 passed; of 62 levelers examined 38 passed; of 79 rodmen, 48 passed, and of 117 chainmen presenting themselves for examination 95 passed. In each case except the last, about 40% of those upon the civil service lists failed to meet the prescribed requirements. As the appointments made last week exhausted the eligible list, another examination will have to be held in about two weeks to fill vacancies. The rates of pay for the several grades are fixed at $5.00, $4.50, $3.50 and $2.50 per day. According to the lists published all successful competitors were from the State of New York; but New York is certainly big enough and good engineers should be plentiful enough within its limits to provide the corps required for this work.

In our announcement last week of the award of Engineering News thesis prizes for 1895, an error occurred through the dropping out of a line, causing the omission of the statement that the college from which the students graduated whose thesis received the second honorable mention was the Ohio State University at Columbus, O.

THE STEAM PIPE EXPLOSION ON THE STEAMER "ST. PAUL".

In our issue of Dec. 19 we gave a brief account of the steam pipe explosion which took place on the American Line steamship "St. Paul," on the morning of Dec. 18. Five men were killed instantly by the accident and four others died shortly afterwards. These were all of the men that were in the engine room at the time. A coroner's inquest has been held, the results of which leave the cause of the explosion in as great doubt as it was the day after the accident. The alarming frequency of steam pipe explosions within the past few years and the fact that other steamships are piped in exactly the same way as the "St. Paul" seem to make it advisable that the whole subject of steam piping and of management of steam pipes carrying high pressures should be restudied with a view of learning all the possible causes of these explosions and of devising ways and means by which they may be prevented in future. The facts of the case, so far as we have been able to learn them, are as follows: The "St. Paul" is a twin-screw steamer with two six-cylinder quadruple expansion engines using steam of 200 lbs. gage pressure. Two high pressure cylinders are mounted tandem above two low pressure cylinders in the forward end of each engine room, and aft of the two low pressure cylinders are in order the second and the first intermediate cylinders. A main steam pipe 15 ins. diameter enters each engine room through the bulkhead at its forward end at about the level of the bottom of the low pressure cylinders. Just inside of the engine room it enters a large stop valve chamber which has two outlets, one below the valve to a cross-pipe which connects with a similar valve chamber in the other engine room, and the other above the valve which admits steam to a vertical pipe. It was



Sketch of Steam Valve on the Steamer "St. Paul" Showing Position of Fracture.

this valve chamber in the starboard engine room which exploded. The accompanying sketch shows approximately the shape and position of the valve chamber, with the location of the first break. The pipe rising vertically from the valve chamber extends upwards 8 or 9 ft. and enters the throttle valve of the engine, from which a horizontal pipe extends aft, parallel to the line of the engines, carrying two branches leading out of it horizontally at right angles to the steam chests of the two high pressure cylinders. Expansion joints of the packed gland type are placed in the cross over pipe, in the vertical riser and in the horizontal pipe above. A 1½ in. drain pipe leads from the bottom of the valve chamber to an automatic trap, by which water of condensation may be drawn away. The valve chamber is of cast-iron. The steam pipes are riveted steel pipes. By-pass pipes 2 ins. diameter and valves are provided so that the pipes beyond the stop valve and also the engine may be warmed up without opening the stop valve. At the time of the explosion, 7 A. M., four hours before the time at which the vessel was to sail, steam had been raised in the boilers to about 130 lbs., and the men were in the act of opening the main stop valve for the purpose of turning over the engine, as appears from the fact that the body of one of the men was found on top of the valve chest, and that the valve was found to be open about 5-16 in.

In the evidence produced at the coroner's inquest it appeared that the cast-iron of which the valve was made was of excellent quality, that the break was a clean one, showing neither blowhole nor flaw, that it was 1⅝ in. thick at the thinnest part, that before the pipe had been placed in the vessel it was tested with an internal pressure of 600 lbs. per sq. in., and afterwards, in place, it, with the whole system of steam piping, was tested to 400 lbs. The automatic drip valve was examined after the accident, and found to be in good order. The vessel had made three round trips across the Atlantic, having run over 18,000 miles, and nothing about the boilers or engines had been found out of order. The verdict of the coroner's jury concluded as follows:

"We find that the said rupture was not caused by the neglect of the steamship company or any of its employes. We further find that the main steam pipes and the stop valves pertaining to the same were and are properly constructed to safely bear the intended working steam pressure of 200 lbs. per sq. in., and that the pressure on the boilers and pipes did not exceed 130 lbs. at the time of said rupture. While we find that the system of drainage of the main steam pipes and stop valves is that usually provided on steamships, we recommend that the drain pipes on the main steam pipes and stop valves in question be enlarged to allow better drainage."

Besides exonerating the steamship company from all liability for the accident, nothing appeared in the testimony to show that the officials of the U. S. Board of Supervising Inspectors were in any way responsible. In the construction of the vessel, everything had been done that is specified in the laws and regulations.

Under the Act of Congress of Feb. 28, 1871, relating to the U. S. Board of Supervising Inspectors of Steam Vessels, a further investigation of the accident will probably soon be held by Messrs. Fairchild and Barrett, the inspectors of the New York District. Such an investigation may not be needed for the fixing of the responsibility for the accident, but it is urgently needed for the purpose of discovering the probable causes which may have led to the accident and the methods by which such accidents may be avoided in future. No accidents happen without a cause, many have two or more causes acting conjointly. The same cause or causes which produced the explosion on the "St. Paul" are now acting or may act on other steam vessels, and if the causes of the present accident are permitted to remain a mystery, the accident may be repeated with even more disastrous results at any time in the future. We may admit that the company, the builders of the vessel, the surveyors of the classification society known as the American Record of American and Foreign Shipping, under whose supervision the vessel was built, the U. S. Supervising Inspectors, and the laws by which they were governed are all to be held blameless for the accident that has taken place, for all that foresight could have done to prevent it appears to have been done; but "hindsight" is better than foresight, and hindsight after an accident may be the foresight which prevents its repetition.

Let us consider what hindsight may show in the case before us. The "St. Paul" with its sister ship, the "St. Louis," are the first large transatlantic steamships designed to run with 200 lbs. steam pressure. It is a big jump from 160 lbs. to 200 lbs., and it causes increased rigidity of the steam pipes and their connections. Cast-iron is a brittle material, and a valve chamber with metal 1⅝ in. thick is exceedingly rigid. If expansion is not properly provided for, it is apt to break an elbow at exactly the point shown in our sketch.. But expansion joints were provided at all points where they appeared to be required. As one officer of the company says, the whole piping system was "floating" and free to move in any direction.. Are expansion joints reliable? They consist of one pipe sliding within another, with a joint packed tight enough to resist 200 lbs. pressure without a leak. How much tighter than this were they packed; and if tightly enough packed could they bring sufficient pull, multiplied by the leverage say of 8 or 9 ft., the height of the vertical riser, to break the elbow valve at its neck? Suppose that the horizontal pipe leading from the throttle valve to the engine had been pushed upwards or downwards

a small amount so that the expansion joint was jammed, it would cease then to be an expansion joint, and the expansion of that length of pipe acting with the leverage of the vertical riser might easily cause the breaking of the elbow. Is it not high time that experiments were made to determine what force may be required to cause the movement of an expansion slip joint when that joint is packed as tightly as it may be packed, and also when it is bent slightly out of line so as to jam. Expansion joints are not always the absolutely reliable safeguards which they are generally supposed to be. In a paper entitled "Remarks on Steam Pipes" by Mr. J. T. Milton, read before the Institution of Naval Architects in 1895 and reprinted in the "Journal of the American Society of Naval Engineers," Vol. VIII., a list of fifteen steam pipe explosions which have taken place since 1887 is given, and in three of them the non-action of the expansion joint was the possible or probable cause. In one case it is stated "an expansion joint was fitted, but it was not arranged to take the strain off the flange." In another the explosion occurred "possibly through want of sufficient provision for expansion." In the third the explosion was attributed to "movement of the boilers and to the expansion joint having become set fast." In the forthcoming investigation, the possibility of non-action of the expansion joints by too tight setting of the packing, by jamming or by any other cause should be examined into, with complete drawings of the whole system of steam piping before the examiners.

Whether or not expansion should be proved to be one of the several possible causes of the accident, a similar investigation should be made in regard to the theory that the explosion was caused by water hammer, and especially whether water hammer may be prevented by any mechanical arrangement or by a strict enforcement of rules and regulations in regard to opening valves and turning steam into large pipes. The evidence at the coroner's inquest goes to show that the pipes were thoroughly drained, the automatic drips being in good working order, so that no accumulation of water in the pipe between the boiler and the valve, by which alone a water hammer could be caused, was possible. Yet some questions may be raised concerning the possibility of water hammer being the cause of the explosion. The vessel being loaded heavily aft, so that the inclination of the steam main in the boiler room was towards the valve chamber that exploded, is it certain that the discharging capacity of the automatic trap was sufficient to prevent a pocket of water forming in the bottom of the valve chamber? Again, suppose that for some time before the accident the by-pass valve which carries steam around the main stop valve to warm up the pipes and the engine had been open, what becomes of the condensation of that steam,, and especially of that which may take place in the vertical pipe above the stop valve? Is there not a chance for pocketing water just on top of the disk of the stop valve? Is there any provision for draining any water that may accumulate there, and if so was that provision in working order at the time of the accident? Suppose the pipes from the boilers to the stop valve were thoroughly drained by the automatic drip, but suppose just before the opening of the stop valve a lot of water were lying above the disk, are not all the conditions for a water hammer present? The mass of water would tend to fall into the chamber below the disk, a great quantity of steam would be condensed by it forming more water, the steam entering the possibly cold pipes beyond the stop valve would condense, forming a vacuum, and the water now lying in the bottom of the valve chamber and in the pipe leading to the boilers, the drip pipe and trap being unable to discharge it, would be hurled with the force of a projectile against the elbow at the bottom of the valve chamber, tending to rupture it in its weakest point. It may be that the valve chamber before the opening of the stop valve was already under strain due to the tight packing of the expansion joint in the horizontal pipe above the throttle, or to jamming of the expansion joint. The water hammer might then act conjointly with the original strain to cause the rupture. Suppose it should be the final judgment of the Board of Supervising Inspectors that the probable causes of the explosion are expansion and water hammer acting conjointly, the next question that arises is what is to be done to prevent such accidents in future. Human ingenuity does not seem to have yet provided any substitute for the slip expansion joint which is less liable to get out of order and nothing better is known for draining pipe elbows and preventing water hammer than the automatic trap. The cast iron elbow may possibly be improved by the substitution of an elbow which will bend slightly rather than break, say one of bronze, of soft cast steel or of malleable cast-iron. Copper elbows might be adopted, but experience with them in the past has been too disastrous for them to be used in future.

Supposing for the present that the piping and valves cannot be improved upon, can anything be done in the management of the piping to minimize if not the probability of an explosion, at least its fatality? Cannot steam be slowly let into the whole piping system and into the jackets and cylinders by means of by-pass valves without opening the stop valve at all, with every drain pipe and cock open, until every portion of the piping, jackets and cylinder are thoroughly heated, and steam is blowing through every opening. Then if the expansion joints are stuck and an elbow breaks from expansion, the amount of steam that can be discharged into the engine room is only that which can be passed through say a 3-in. pipe instead of that from a 15-in. pipe. To prevent the damage from water hammer, cannot a regulation be made that the stop valve shall not be opened until after steam has been blown clear through the system by the by-pass valve, and an assistant engineer has inspected every drain from the pipe to insure that there is no water pocket in any portion of the system?

Two facts concerning water hammer appear to be incontestable; first, that its force is almost irresistible and hence no steam piping system can be made strong enough to resist it; second, that it never takes place except when either there is water in the pipe when the hot steam enters it or water is formed by the condensation of the entering steam on the cold surface of the pipe. Of the fifteen steam pipe explosions recorded in the paper of Mr. Milton, referred to above, seven of them were attributed to water in the pipe. A series of experiments recently made in Germany to determine the causes of explosions on board German war vessels, the report of which is translated in the "Journal of the American Society of Naval Engineers," Vol. VII., showed that pressures could be produced by the flow of steam into a pipe containing water which exceeded the capacity of the pressure gage to register, its maximum registry being 2,133 lbs. per sq. in., but in the same experiments no dangerous pressures were produced except when water was pocketed in the pipe. "It is to be observed," says the record of these experiments, "that a rapid filling of the pipes with steam may prove disastrous, for the sudden heating up of the various parts may cause rupture due to unequal stresses on and resistance of the material. When, however, a large quantity of water is contained in the pipes and the steam is forced to find its way through it and carry it along, an explosion may occur even if the stop valve is opened in the slowest and most careful manner."

We trust that the Board of Supervising Inspectors, in their investigation of the explosion on the "St. Paul" will not confine themselves to an attempt to find the cause of, or to fix the responsibility for this peculiar explosion, but will take some pains to determine what, if any, changes should be made in our present methods of constructing steam-piping, elbows, valves, expansion joints, drainage pipes, traps, etc., and what rules for management of these contrivances should be made in order to prevent a repetition of such serious accidents in the future.

A hydrographic survey of Georgia has been ordered by the U. S. Geological Survey, and Mr. Benjamin H. Hall, a civil and mining engineer of Atlanta, Ga., has been placed in charge.

THE DIVISION SUPERINTENDENT AND HIS WORK.

In another column of this issue the organization, equipment and work of a railway division are described in detail, and it may be of interest in this connection to briefly consider the duties of the division superintendent, who, under the most approved system of organization, is the absolute head of the division and controls all its departments of work, including train service, maintenance of way, and equipment. A railway division, under this plan of organization, is a small railway system in itself, and its proper management calls for as much care and attention to detail in order to ensure efficiency, economy and general satisfaction to the company and its customers, as does the management of an entire railway. The duties of and the mental requirements for the position of division superintendent make this one of the best positions for training men for the highest executive positions in the railway service, since it gives the incumbent actual knowledge of and contact with all the varied details of railway operation, and puts him in a position to know all about the property, the men, the traffic, and the customers. In a speech at the annual dinner of the American Society of Railroad Superintendents, it was pointed out that the superintendent must be a man of patience and persistence, firm but just in his dealings with employees and patrons, straightforward, yet not wanting in tact, able to use what material he has to the best advantage, yet capable of showing good reasons for asking for better things, prompt to take advantage of opportunities and to devise or modify plans of action, acquainted with commercial principles and methods, capable of handling men, good natured, yet not familiar, of untiring energy, full of readiness and ingenuity, and prompt for action in any emergency. He is usually familiar with the history of the road, has the physical condition and equipment of the road (or of his division) at his fingers ends, knows the temper and capacity of his men, has knowledge of traffic agreement with other roads, is posted as to the financial condition of the company (by which he regulates his expenditures and requisitions), and is not unfrequently a student of the principles of railway economics, which latter term is too often considered by higher officers as synonymous with "economies." If he is an educated and experienced engineer, as is often the case, so much the better, not only on account of the value of his technical knowledge, but also on account of the value of his training as an engineer. All these qualifications are just those required by the man who guides the affairs of a large railway system, from a higher platform and on a somewhat broader scale than the Division Superintendent.

To return to the duties of the position, it may be explained that the superintendent is in practical charge of the operating service of the railway, and on all roads of any importance there is one General Superintendent, whose jurisdiction is over the entire line, and several division superintendents, each having jurisdiction over a certain division of the line. Two different systems are in use, with respect to the powers and duties of the division superintendent. In the first, he is given absolute control over his division, being the superior officer of the divisional force. In the second, he is merely a departmental head, ranking with the division master mechanic and the division engineer or roadmaster. In this latter case he is practically little more than a trainmaster or superintendent of train service, and has little or no absolute authority, having to refer all matters of detail to the superior authority at headquarters, which authority has no personal knowledge of the local conditions or affairs. Under such conditions of divided authority there will almost of necessity be a great deal of formality and delay in regard to the every day matters of the service, with consequent loss of time, money and opportunities and with probably more or less friction between the officers. This is not only the case in the dealings between the public and the railway, but also in the operating details. Thus, if the superintendent wants to send a work train out to any part of his division he has to apply to the motive power department for an

engine, and may not get an engine suitable for the service required. Similarly, if any part of the track requires prompt attention a communication may have to be made to the general superintendent and then referred to the general manager, from whose office it is again referred to the chief engineer or head of the maintenance of way department, and thence through subordinate channels.

By far the better practice, as is now very generally recognized, is to make the division superintendent the man in direct charge of the division, with power over all departments. Under such conditions he reports only to the general superintendent, but he is of course, compelled to observe and abide by the general regulations and the standards of construction, etc., adopted by the company. On the Erie R. R., as described in another column, the division superintendent is in charge of the entire equipment and work of the division, including the maintenance of way, the providing and caring for the motive power and equipment, and the movement of passenger and freight traffic. He has under him a trainmaster, chief train dispatcher, roadmaster and master mechanic, and he reports to the general superintendent and the superintendent of transportation. The higher officials are therefore not compelled to attend to matters of detail referred to them from various divisions, but all such matters are attended to directly by the local authority, who is conversant with all the affairs of his division. Records and accounts are, of course, kept by the general superintendent, and monthly statements are usually prepared showing the traffic, expenditures, etc., of each division, so that a comparison may be made as to the efficiency and economy obtained on different divisions.

At the meeting of the American Railway Association in October, 1895, Col. H. S. Haines, the President, delivered an address on this subject. The main issue to be determined is whether the departmental responsibility should continue through directly to the head of the department, regardless of the territorial divisions, or whether it should be concentrated in each of these divisions before reaching the head of the department. He considered that the proper test to be applied is that of the greatest efficiency at the least cost, and this again involves the placing of responsibility where it cannot be shifted in case of failure or neglect. If a man is held responsible, he should certainly have control over the matters for which he is held responsible, and his authority should extend so far as he is expected to act independently. The multiplication of offices and consequent multiplication of business and division of responsibility, may undoubtedly be avoided by extending the authority of the division superintendent of transportation to some extent, so as to cover the operation of the roadway and machinery departments within the limits of his division. The roadway force can very well be put under the authority of the division superintendent, who must conform to the standards (such as rails, switches, frogs, etc.) established by the chief engineer, so as to ensure uniformity, the chief engineer also establishing regulations as to the use of standards and being in direct charge of important structures. The division superintendent is more familiar with the local details of track, roadway equipment, etc., than the chief engineer can be, and is therefore better able to control the general work of maintenance upon his division. In the same way, a considerable amount of work for the roadway and motive power departments is done in the division shops, and there should be no division of responsibility in case of neglect or delay to carry out work, or in case of defective work. Then again, the division superintendent, who is constantly out on his division, knows much more about the power required, the train loads, etc., than the superintendent of motive power can be expected to know, and he is therefore better fitted to judge as to the capabilities of the engines, and the best way of combining economy in operation with efficiency of service.

The following is an abstract of some of the conclusions presented by Col. Haines in the address above referred to:

Applying these principles of responsibility and authority to railway management, it would seem best to give free rein to a division superintendent up to that point where it is essential to the welfare of the transportation system as a whole, that his course should be brought in accord with the course of other officials outside of his sphere of action. His sphere of action is his division of the road, and within that division there should be no divided authority covering the transportaton of persons or things with safety and dispatch. But for this to be successfully accomplished, the operations upon his own division must be in certain respects co-ordinated with the operations upon other divisions of the road. Here come into play the general rules for the movement of the trains and the regulation of the conduct of employees, the preparation and observance of through time-tables, and of mechanical standards. His authority upon his division is exercised subject to those restrictions which must necessarily be prescribed by an authority superior to his own. In these respects, then, his responsibility does not extend beyond the observance of such restrictions.

The conclusion to which this reasoning brings us is that within the territorial authority of a division superintendent, all railway operations should be under his supervision, except as to regulations, standards, important purchases and the inspection of important structures. The threads of authority thus gathered together in his hands should from that point tend to the three department heads, the chief engineer, the mechanical superintendent, and the general superintendent of transportation, to be again brought together in the general manager's office.

To the people having business with the road, the division superintendent is the embodiment of the corporation. When they want anything they go to him for it, and if it is evident to them that he can answer nothing definitely, but that matters of routine have to be referred to a distance for the endorsement of some superior official before a definite answer can be given, they not only chafe at the delay, but they feel that an adverse decision is due to the fact that they have not been heard, that they have not had their day in court. For these reasons, therefore, the division superintendent should be entrusted with very considerable discretionary powers in dealing with the people among whom he lives and with whom he is in daily communication. By all means then the division superintendent should be held up to the public as the immediate authority in all matters of ordinary interest to them, and should be invested with power corresponding to that position. It is a mistake to make of him nothing more than a chief of train service, a mere link in an endless chain of officials propelled by motive power a thousand miles away.

LETTERS TO THE EDITOR.

The Proper Consistency of Concrete After Mixing.

Sir: In your issue of Dec. 12, 1895, Mr. A. S. Cooper publishes a table showing the comparative strengths at different ages of cement mortars mixed with various percentages of water. From this he concludes that within certain limits, the higher the percentage of water, the greater will be the ultimate strength of the mortar. It would seem that this table is not conclusive. In the first place, as I understand it, these tests were for only one kind of natural cement, and hence cannot be taken as establishing any general principle. Then, too, tests of natural cements usually show great fluctuations in strength during the first few weeks of setting. This is especially noticeable if the briquettes are hardened in air. It must also be borne in mind that the conditions governing the setting of mortar in a briquette mold are very different from those usually present in actual work. In the one case the conditions are most favorable and the mortar is allowed to set without disturbance. In the other case the mortar being spread or tamped is often roughly handled, and any excess of water is apt to wash the cement out of the mortar. The presence of a considerable amount of water will permit mortar to be spread after its tendency to set is entirely gone, while it would be difficult to do this with a comparatively dry mixture without attracting attention. I have taken down old bridge piers that had been built with a fair quality of cement mortar spread wet, in which the mortar was of the consistency of ashes. Such instances are, of course, a matter of common experience. It is doubtless true that in the special case discussed by "S. F. X." and Mr. Johnson (Eng. News, Nov. 21, 1895), a limited excess of water would seem advisable, but it would hardly seem to be good practice for ordinary masonry construction. As Mr. Cooper says, the general tendency of workmen is to use an excess of water, and to countenance this in the specifications even to a limited extent would be apt to lead to greater carelessness in this respect. The tests to which I refer in spreading of natural cement are those made at the State University of Iowa in 1890 and 1891, the results of which were in part published in the Engineering News of Feb. 7 and Nov. 21, 1891.

Yours truly, Alden H. Brown.

Fruithurst, Ala., Dec. 20, 1895.

Sir: If I am not too late to join in the discussion relative to the proper amount of water to be used in mixing concrete, I would like to be heard on the subject. Of late years a school has sprung up which advocates the use of much less water than many consider essential to the production of the best work; claiming that the material should be only moistened with about the amount of water chemically needed, or a little more, and but little if any water should be in such excess as to be capable of being forced out by ramming or compacting. What data have they, the advocates of this school, brought forward to substantiate their theory? So far as I know, they depend upon one known fact only, viz., that briquettes for cement testing are the strongest when so made.

Now I question the inference from this fact. Concrete with the usual aggregates is a very different thing from cement or cement and sand. It differs in relationship to the water of the mixture in several ways. (1.) The aggregates are usually large absorbers of water. (2.) Wet concrete, i. e., concrete having ample water—an excess of water, so to speak—can be compacted, whereas cement, or cement and sand so mixed, cannot. (3.) Concrete mixed after the manner of the new school, especially if the aggregates consist in part of broken rock will "arch" on placing, and no ordinary compacting will break it down.

By the use of a liberal quantity of water, the aggregates become more impregnated therewith, and as they later on return this water to the cement, the latter is kept in a moist condition longer, and consequently hardens more quickly and thoroughly. An excess of water can be driven from the mass during the tamping or rolling, and it will be found that arching is reduced to a minimum. In making concrete it has been found that a more dense and compact stone can be made with a liberal use of water; for, with a properly proportioned aggregate of good quality an excess of water does not retard nor hinder compaction. On the contrary, with properly shaped tampers it accelerates it. And the reason is not hard to reach. The well known experiment of Bamber is very instructive on this point.

I question if any one who has devoted his attention to concrete construction for any considerable time, can be found who, in his own unrestricted practice, uses the so-called "dry mixing," excepting where it is advisable for convenience of handling, such as in the case of pavements, artificial stone blocks, etc. In mixing concrete sufficient water should be used to bring the mass, after a thorough mixture, into a stiff, tenacious condition, and more concrete of late years has, I think, been injured from the use of too little water than from too much.

Yours truly, Ernest L. Ransome.

Chicago, Ill., Dec. 24, 1895.

THE PASSAIC & NEWARK ELECTRIC RAILWAY.

(With Inset).

An electric railway from Passaic, N. J., to a connection with the lines of the Consolidated Traction Co., of Newark, is now being built by the Passaic & Newark Electric Traction Co. The total length will be 6.13 miles, of which 4.05 miles, from Passaic to Franklin, have been completed and are in operation; another length of 1.23 miles from Franklin south to the Belleville township line, has just been completed and will soon be in operation, and the remaining length of 0.85 mile will be proceeded with as soon as the franchise has been secured from the township of Belleville. The contractor is Mr. L. W. Serrell, of 99 Cedar St., New York. The engineers are Messrs. Wise & Watson, of Passaic, N. J., and we are indebted to Mr Colin R. Wise for drawings and general information. Gen. Bird W. Spencer is President of the company.

The contract includes furnishing all tools, materials and labor, grading the roadbed, laying and surfacing the track, laying 5 ins. of macadam (and 12 ins. on Washington Ave.), extending existing culverts and constructing the overhead wiring, etc.

The rails, Fig. 1, are of steel, of girder section, with side-bearing heads, and weigh 70 and 85 lbs. per yd., the heavier rails being laid on Washington Ave. They are laid with broken, suspended joints, spliced with 24-in. flat plates and six bolts, spaced 4, 4½, 4½, 4½ and 4 ins. c. to c., as shown in Fig. 2. They are secured by spikes 9-16 × 5½ ins. to cross ties of white, post or burr oak or chestnut, the ties being 6 × 7 ins. section and 7 ft. long, spaced 25 ins. c to c., or 14 ties to each

30-ft. rail. Combination braces and tie plates of 7-16-in. steel are used, four to each rail on tangents and six on curves. These plates, shown in Fig. 1, have a base of 10 × 4 ins., and weigh 4 lbs. each. The gage is 4 ft. 8½ ins., widened on curves, and the super-elevation on curves is given by raising the outer rail or lowering the inner rail as occasion demands. All rails requiring to be cut must be sawed, no cutting by cold chisels being permitted. The tracks are 4 ft 8½ ins. apart between gage lines of inner rails, except on Washington Ave., (which is 100 ft. wide), where they are laid at the sides of the telford paving, or 22 ft. 6 ins. apart, as shown in Fig. 3. Split switches and rigid frogs are used.

All the rails have two 9-16-in. holes at each end for two Chicago rail bonds of No. 00 B. & S. gage tinned copper wire, Fig. 4. These bonds are placed so deep that no wheels can reach them and shear them off. Cross bonds are placed at intervals of 200 ft., and connected to the rail bonds on either side by two tinned copper wires. On double track there are cross bonds at intervals of 1,000 ft., these being the same size as the rail bonds. The bonding is shown in Fig. 5

The poles are of wood and iron, the latter being required by the county authorities on Washington Ave. The wooden poles are of long-leaf yellow pine, 30 ft. long and octagonal in section. The bottom is treated with a preparation of coal tar, or some equally good preservative, to a height of 6 ft., and the remainder is given two coats of olive green paint. The poles used on tangents are 10 ins. diameter at the butt and 8 ins. at the top; while these used at street corners, or which in any way bear much of the pull of the trolley or feed wires, are 13 and 10 ins. diameter at the butt and top respectively. All poles on tangents and on curves of 300 ft. or greater radius, are set 6 ft. in the ground, and have a rake of 4% (or 0.96-in. in 24 ft.). Those at corners and terminals, and others which have to bear a heavy strain, are set 6 ft. 6 ins. in the ground (set in concrete), and have a suitable rake. The poles are not more than 125-ft. apart, and are placed 12 ins. inside the curb line of the street. Corner poles are fitted with strong eye-bolts for the attachment of guy wires, etc. No pike poles were allowed to be used in the erection of the poles, nor spurs used in painting them. The cross-arms are of the best pine, 3¾ × 4¼ ins., and are snugly fitted in gains in the poles, and each secured by two iron braces ¼ × ⅝ × 28 ins. At all corners the poles are fitted with double cross-arms. The insulator pins are of iron at the corners, and of selected oak or chestnut on straight line work. They fit the cross-arms closely. The poles and cross-arms are shown in Fig. 6.

The span cables are of stranded wire 5-16 in. diameter, made of seven soft drawn No. 12 galvanized steel wires without a core, and are secured to drop-forged eyebolts ⅝-in. diameter, which pass through the poles and have a nut and washer on the opposite side of the pole from the tracks. The eye-bolts are sufficiently high to hold the trolley wires 18 ft. above the rails, as shown in Fig. 3. The bolts have sufficient length of thread to allow 4 ins. of "slack" to be taken up after the spans are in position and the poles well set. The trolley wires are No. 0 B. & S. gage, hard-drawn copper, and have 97% of the conductivity of pure copper. They are thoroughly insulated from their supports. The wire was put up in as great lengths as could be conveniently handled, being run off the reels upon which it was carefully wound, and handled so as not to bend, kink or scratch it. Joints in the trolley wire are made by splicing-ears of the best and latest style, and no joints occur in or near sharp curves. The line insulators are of the latest style. On tangents they are General Electric mechanical clips. On sharp curves and at such other points as the engineer directed, the ears were soldered to the trolley wire.

The trolley line is double-anchored at all grades and curves, and at intervals of at least 1,000 ft. The wire used for anchor lines is the same as that used for span wires. Each pole to which the wire is anchored is back guyed to the next pole. Eye-bolts are used in all cases, no guys being allowed to be wound around any pole or tree. "Pull offs" are used at all curves, overhead switches, etc., to properly center the trolley wire over center of track. All "overhead-frogs" are well guyed. Some form of insulator is used in each anchor wire, two or three feet from the anchor-clamp.

Lightning-arresters are put upon the poles about 1,500 ft. apart and are attached to the bond-wires of the track and to the feeder-wire connections. Tree-insulators, Fig. 7, are used to provide against losses and dangers which result from abrasion of feeder wires.

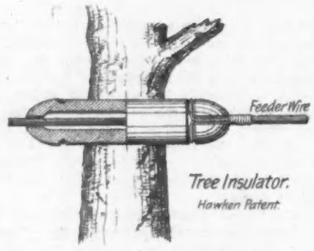


FIG. 7. TREE INSULATOR.

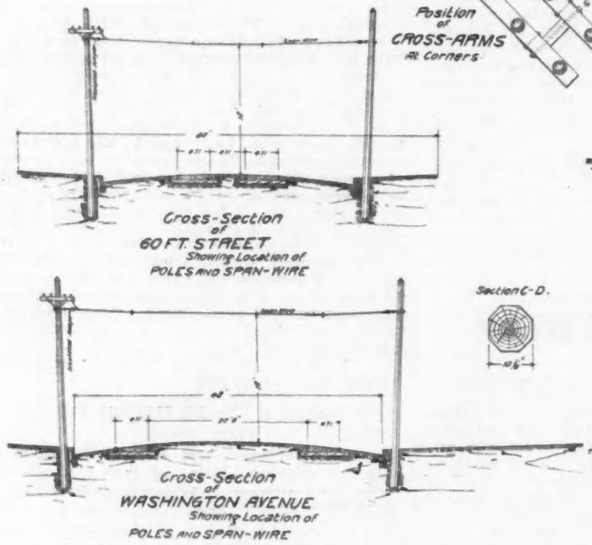

Position of CROSS-ARMS On Straight Lines.
Section A-B
Position of CROSS-ARMS At Corners.
Cross-Section of 60 FT. STREET Showing Location of POLES AND SPAN-WIRE
Section C-D.
Cross-Section of WASHINGTON AVENUE Showing Location of POLES AND SPAN-WIRE

Fig. 3. Cross Section Showing Arrangement of Tracks.

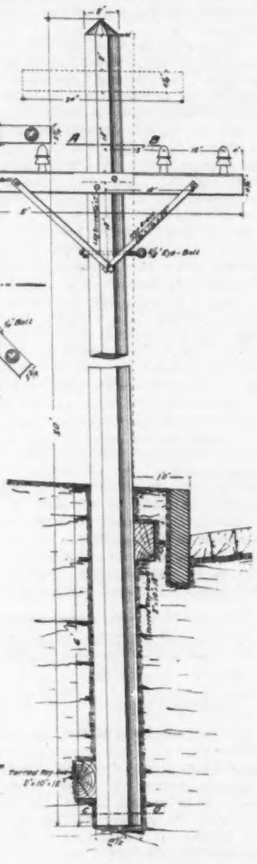


Fig. 6. Poles and Cross Arms.

The trestle shown in Fig. 8 was designed as a temporary expedient to get across the valley of Third River until the county of Essex should proceed with the rebuilding of the wooden bridge across the valley. In regard to the absence of longitudinal bracing, Mr. Wise explains that believing that it might be two or three years before a new bridge would be built, the engineers in their first plans provided for longitudinal diagonal bracing, waling, etc., but that as soon as the company was informed that the county proposed to at once proceed with the construction of the bridge, the engineers were requested to cut down the bill of timber as much as possible, and, as the end bents would be well covered with the embankment, the longitudinal bracing, etc., was left out. While the materials for the trestle were provided and on the ground, and the approaches graded, the trestle was not erected, because it was seen that the new stone arch would in all probability be completed before the franchise in Belleville township could be secured, and until this was done nothing would be gained by erecting the temporary trestle. The stone structure is now complete and ready for the tracks of the electric railway company. It has three arches of about 45 ft. span and was built according to the plans of Mr. James Owen, M. Am. Soc. C. E., County Engineer of Essex county. The cost of constructing the stone bridge and filling the valley to a height of over 22 ft. has been divided equally between the county and the electric railway company. The trestle was to be 225 ft. long, with frame bents 12 ft. 6 ins. c. to c., and a 25-ft. truss over Third River. The double tracks were to be gantleted across the structure, as shown. Fig. 9 shows some of the details of the trestle and truss.

A curve of 40 ft. radius, turning a right angle at a street corner and having its ends suitably transitioned to 200 ft. radius at the tangent points, is shown in Fig. 10.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Damages by Surface Drainage.

The rule of the common law is, that surface water is a common enemy, and that the owner may defend his premises against it by dike or embankment; and if damages result to adjoining proprietors by reason of such defense, he is not liable. But this rule is a general one, and subject to another common-law rule, that a proprietor must so use his own property as not to unnecessarily and negligently injure his neighbor. And therefore every proprietor may lawfully improve his property by doing what is reasonably necessary for that purpose, and, unless guilty of some act of negligence in the manner of its execution, will not be answerable to an adjoining proprietor, although he may cause the surface water to flow on the premises of the latter to his damage. But if, in the execution of such enterprise, he is guilty of negligence which is the natural and proximate cause of the injury to his neighbor, he is accountable therefor.—City of Beatrice v. Leary (Supr. Ct. of Neb.), 63 N. W. Rep., 371.

Liability for Municipality for Surface Water.

Where a municipal corporation, by grading and paving streets, prevents the absorption of rain, which is consequently discharged on adjoining land in greater quantities than it would otherwise have been, the municipality is not liable for the damages caused thereby, as it cannot be compelled to construct drains to dispose of surface water.—Anchor Brewing Co. v. Village of Dobbs Ferry (Supr. Ct., Gen. Term, 2d Dept.), 32 N. Y. Sup. Rep., 371.

City May Not Light Private Buildings.

The power conferred upon cities of the second class having over 5,000 inhabitants to provide for and regulate the lighting of the streets, implies the power to erect and maintain an electric lighting system for that purpose. From the power to provide for and regulate the lighting of streets, however, no power can be implied to erect or maintain a lighting system for the purpose of supplying light to private buildings.—Christensen v. City of Fremont (Supr. Ct. of Neb.), 63 N. W. Rep., 364.

Injury by Electric Railway to Abutting Property Owner.

The use of a street for an electric railway does not impose an additional burden or servitude to that implied by the dedication. The proper construction and operation on a street where there were two other such railways, and so near an abutting store building as to inconvenience the occupants in receiving and delivering goods, is not such an infringement on the right

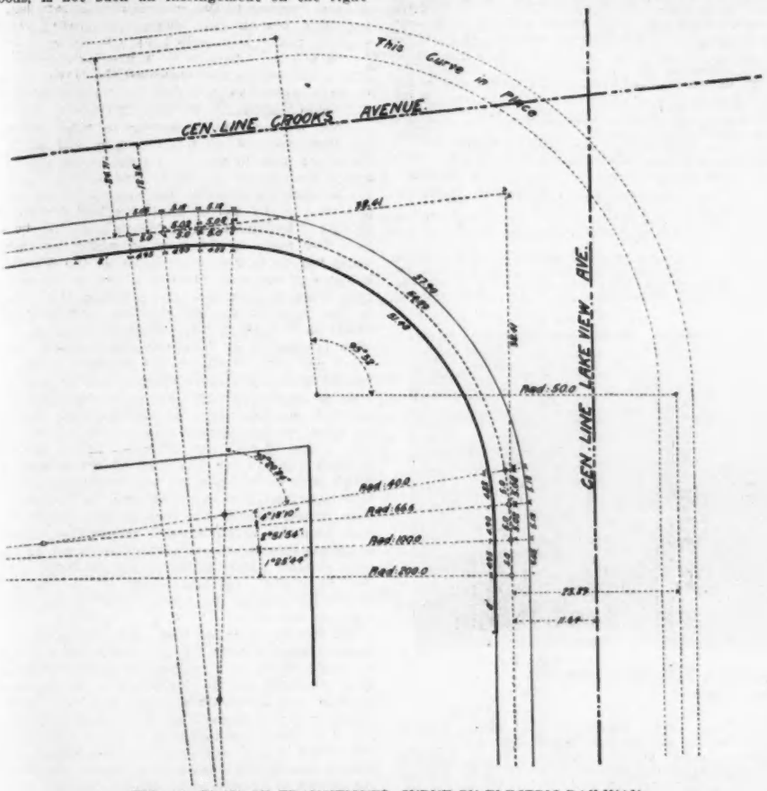


FIG. 10. PLAN OF TRANSITIONED CURVE ON ELECTRIC RAILWAY.

When Agreement to Abide by City Engineer's Decision is Binding.

A contract for the improvement of a street provided that "to prevent all disputes and litigation" the city engineer's decision as to the work shall "be final and conclusive." It was held by the court that one of the parties could not avoid being bound by the engineer's decision by showing merely that he was negligent and made mistakes.—Bowman v. Stewart (Supr. Ct. of Penn.), 30 At. Rep., 988.

Liability for Negligence of Fire Department.

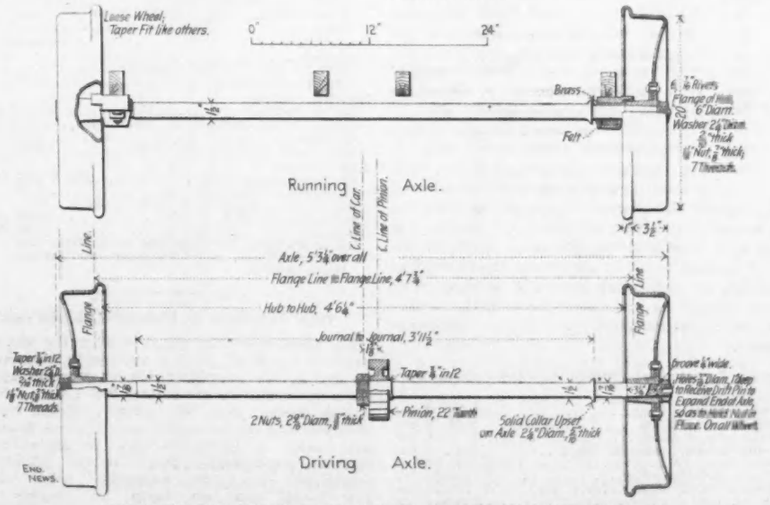
A municipal corporation is not liable for the negligence of the members of its paid fire department in the management of their apparatus or the performance of their other duties about the extinguishment of fires, such duties being a public service for the general welfare, in which the corporation has no private interest.—Mayor, etc., of City of New York v. Workman (Circ. Ct. of App., 2d Circ.), 67 Fed. Rep., 347.

Revocation of Consent to Build Street Railway.

Where consent to construct a street railway was revoked by the local authorities for the company's failure to complete the line within the time specified as a condition of the consent, the facts that the company acted in good faith, and that the revocation caused it great hardship, constituted no ground for refusing an injunction restraining its further building operations.—Township of Plymouth v. Chestnut Hill & N. Ry. Co. (Supr. Ct. of Penn.), 32 At. Rep., 19.

METHODS OF ATTACHMENT OF HAND-CAR WHEELS TO AXLES.

The accompanying cut represents the arrangement of loose wheels and the taper bearing and hub used by the Sheffield Car Co., of Three Rivers, Mich., for its hand-cars. It is this company's practice to have one loose wheel to a car, as this makes the car easier to handle. The wheels of the driving axle are, of course, made tight to the axle, and the loose wheel is placed on the other axle. The usual method has been to fasten the wheels to the axles by means of keys, but there is often a difficulty in getting close fits, and as a consequence the keys work loose, while if there is any variation in the size of the hole in the wheel hub or the turned seats on the axles, the tendency of the key is to draw the wheel out of true with the axle, and thus a wabbling motion is given to the wheel when the car is propelled. The wheels might be pressed on by hydraulic pressure, but the objection to this construction is that the car would have to be shipped to the factory or a shop where there was a hydraulic press in case the wheels were to be renewed. With the taper fit, however, it is claimed that a perfectly-running wheel is obtained, the variation in hole or axle being taken up by the taper, while new wheels can be put on axles at any point on the line.



TAPER FIT FOR WHEELS AND PINIONS OF THE SHEFFIELD HAND CAR.

The method of fastening the pinion to the driving axle by means of a key has the same objection as that of fastening the wheels in this way, and quite frequently the keyed pinion will not run true. With the use of the taper fit, however, the pinion is found to run perfectly true, and there is no trouble with the key working loose, which has been a source of considerable trouble. As now made, the Sheffield car has not a key in its entire construction.

EIGHT-WHEEL EXPRESS LOCOMOTIVE; CHICAGO & NORTHWESTERN RY.

The increase in speed of passenger trains on western roads is leading to the use of engines specially designed for high speed service, such engines being usually modifications of standard engines which have been found satisfactory in somewhat similar service, although in some cases a new type is introduced, such as the Columbia type of the Chicago, Burlington & Quincy R. R., illustrated in our issue of Dec. 1895.

The Chicago & Northwestern Ry. has been shortening the time of some of its through express trains carrying the mails and has had several powerful eight-wheel engines, with 75-in. driving wheels, built specially for this service by the Schenectady Locomotive Works. One of these engines we illustrate herewith, and are indebted to Mr. A. J. Pitkin, Superintendent of the Schenectady Locomotive Works, Schenectady, N. Y., for photographs, specifications, etc. Their main service is on the line from Chicago to Council Bluffs, 490 miles, where frequent stops necessitate high speeds to maintain the schedule time, though the average speed throughout the run is not very high. The trains have from 8 to 11 cars, of which latter number 6 are sleeping cars, and a speed of 72 miles per hour has been developed with 8 cars on an up grade of 0.7%, two miles long. The engine developed 1,268 H.P., and the mean effective cylinder pressure was 55 lbs. at one end and 62 lbs. at the other end. The boiler pressure was 180 lbs., and the throttle was half open.

The driving wheel centers are of cast steel, 5 ft. 8 ins. diameter, and the tires are secured by shrinkage. The driving-boxes are of steeled cast iron, which is a tough gray cast iron with an admixture of steel to increase its tensile strength. The engine truck has Snow boltless spoke wheels, and the tender has Snow boltless plate wheels. Cast iron rings are used for packing the pistons, and the Jerome metallic packing for the piston rods and valve stems. The cylinders have bushings ½-in. thick, and false valve seats, 1¼ ins. thick, are also used. The main rods and side rods are of I-section, and all valve and eccentric rods are straight, thus avoiding the evil effects arising from curved or offset rods. Steel castings are used in many places instead of iron castings, a considerable reduction in weight of parts being thus effected. The axles are of iron, and the crank pins of case-hardened iron.

The boiler is of the extended wagon-top type. The circumferential seams are double-riveted and the horizontal seams are butt-jointed, multiple-riveted, with cover strips both inside and outside. The dome is on the wagon top, near the throat sheet, and the safety valves and whistle are mounted on a separate fitting, an arrangement which is quite common in English practice and is now in use on several roads in this country.

The firebox is of Schoenberger steel, with the crown sheet stayed by 1-in. radial stays, while the staybolts are of Taylor iron ⅞-in. and 1-in. diameter. The tubes are of charcoal iron, No. 11 B. W. G., and the firebrick is supported on four 3-in. tubes of No. 10 B. W. G. The grates are of the rocking style with drop plate; and the ashpan is sectional, with front and back dampers, 27 and 36 ins. deep respectively. A single high exhaust pipe is used, with nozzle 4¾, 5 and 5¼ ins. diameter. The smokestack is of cast iron, 14 ins. smallest diameter (above the smokebox) and 16½ ins. diameter at the top. The boiler feed is supplied by two No. 10 Monitor injectors. The cab is of iron (a construction which seems to be growing in favor), and it has a wide deck beyond the boiler head, while its roof projects over the tender deck.

The tender has a metal frame of angle iron ¾ × 4 × 6½ ins., and the trucks are of the diamond pattern, having channel iron bolsters, with center bearings on front and back trucks and side bearings

EIGHT WHEEL EXPRESS LOCOMOTIVE; CHICAGO & NORTHWESTERN RY.
Schenectady Locomotive Works, Builders.

on the back truck. It carries 4,350 gallons of water and 8 tons of coal. Spring buffers are fitted between the engine and tender. The sides of the coal space are inclined, so as to feed the coal down to the deck.

A notable feature is the application of the air brakes to the engine truck wheels, a practice which is coming more and more into use for engines in express train service, and the advantages of which have been discussed in our columns. The engine has the American-Westinghouse brake on the truck, and the Westinghouse automatic air brake on the driving and tender wheels and for the train. All the brakes are arranged on the "spread" plan, being hung inside the wheels. A 9½-in. air brake pump is used, and the equipment also includes the Westinghouse air signal for the engineman. The pilot is of wood, and a coupler head is bolted to heavy plates on the bumper beam. The bell is mounted on the throat sheet and is operated by a Gollman bell-ringer. The sandbox is on the front barrel ring, with a straight lead from the box to the rail, thus avoiding the usual bends in the pipe. The sand is fed by air from a Leach sanding apparatus. A cylindrical headlight is used. The general dimensions and particulars of the engine are given, in our standard form, in the accompanying table.

Express Locomotive; Chicago & Northwestern Ry.

Running Gear.	
Driving wheels, diam.	6 ft. 3 ins.
Truck wheels, diam.	3 ft. 0 ins.
Tender wheels, diam.	3 ft. 0 ins.
Driving wheel, centers, diam.	5 ft. 8 ins.
Engine truck	Rigid center.
Journals, driving axles	8×11 ins.
Journals, truck axles	6×10 ins.
Journals, tender axles	4½×8 ins.
Journals, main rod crank pins	5½×5½ ins.
Journals, side rod crank pins	4½×4 ins.
Wheel base.	
Driving	8 ft. 6 ins.
Truck	6 ft. 0 ins.
Total engine	23 ft. 1 ins.
Total tender	15 ft. 10 ins.
Total engine and tender	47 ft. 6 ins.
Truck pin to leading driver	11 ft. 7 ins.
Total length over engine and tender	56 ft. 8½ ins.
Weight in Working Order.	
On driving wheels	78,000 lbs.
On truck wheels	47,600 lbs.
Engine, total	125,600 lbs.
Tender, total	92,400 lbs.
Engine and tender, loaded	218,000 lbs.
Tender, empty	41,020 lbs.
Of full coal capacity	16,000 lbs.
Of full water capacity of tank	35,380 lbs.
Allowed for water in boiler	15,000 lbs.
Cylinders.	19×24 ins.
Distance, center to center	6 ft. 5 ins.
Distance, center to valve face	3 ins.
Piston, horizontal thickness	5¼ ins.
Piston rod, diam.	3¼ ins.
Form of crosshead and guides	Four-bar.
Connecting rod, length between centers	7 ft. 7½ ins.
Valve Gear.—Type	Allen-Richardson.
Ports, steam	1⅝×20 ins.
Ports, exhaust	3×20 ins.
Bridges	1⅝ ins.
Slide-valves, lap (outside)	1¼ ins.
Slide-valves, lap (inside, clearance)	⅛ ins.
Slide-valves, max. travel	6 ins.
Slide-valves, lead in full gear, 3-16-in. blind, forward motion; back eccentric set to give ¼-in. lead at 6 ins. cut-off, forward motion.	
Boiler.—Type	Extended wagon-top.
Diam. of barrel, first ring (outside, 5 ft. 2½ ins.) inside	5 ft. 1 ins.
Thickness of barrel plates	9-16, 5/8, 11-16, ½ and 7-16 ins.
Thickness of smokebox tube plate	½ ins.
Height from rail to center line	8 ft. 8 ins.
Length of smokebox from tube sheet	5 ft. 6½ ins.
Working steam pressure	190 lbs.
Firebox.—Type	Radial stayed; above frames.
Length inside, at ring, 8 ft. 3-16 ins.; at tubes	7 ft. 11 11-16 ins.
Width inside	3 ft. 4⅝ ins.
Depth at front	6 ft. 5¼ ins.
Depth at back	5 ft. 5¼ ins.
Thickness of side plates	5-16 ins.
Thickness of back plates	5-16 ins.
Thickness of crown sheet	⅝ ins.
Thickness of tube sheet	½ ins.
Grate area	26.96 sq. ft.
Staybolts, diam., ⅞ and 1 in.; pitch, not over	4 ins.
Water space, width, front, 4½ ins. at bottom; at waist	5 ins.
Water space, width, sides, 4 to 4½ ins; back	4 ins.
Tubes.—Material	Syracuse iron.
Number	287
Diam., inside, 1¾ ins.; outside	2 ins.
Length over tube plates	11 ft. 6 ins.
Heating Surface.	
Tubes, exterior	1,715.6 sq. ft.
Water tubes (supporting firebrick)	28.8 sq. ft.
Firebox	159.3 sq. ft.
Total with exterior tube area	1,903.7 sq. ft.
Miscellaneous.	
Exhaust nozzle, diam.	4¾, 5 and 5¼ ins.
Smokestack, smallest diam.	1 ft. 2 ins.
Smokestack, height from rail to top	14 ft. 11 ins.
Capacity of tank	4,350 gallons.
Capacity of coal space	16,000 lbs.
Brake fittings, Westinghouse on driving and tender wheels, and American on engine truck wheels.	

TRUE ECONOMY IN LOCOMOTIVE SERVICE.*

The question is often asked whether the modern locomotive moves as great a tonnage in proportion to its size as the smaller engine of 20 years ago did. Facts show that we are getting better work with the modern engine. Have we, however, reached the limit with the modern locomotive, and have we determined how much a locomotive can be made to earn for the company? The question should be considered from one standpoint only, that is, how much can we make an engine earn? To make it earn all it can, the idea must be abandoned that an engine should run from 75,000 to 100,000 miles before it is taken to the shop. When freight engines are kept in service until that mileage is made the company is not getting the revenue the engines could earn. An engine in freight service should haul every ton of freight it is capable of hauling, regardless of cost for repairs and fuel. When locomotive performance is considered on a mileage basis, or with reference to how cheap it can be run, and how many miles it will make between general repairs, an effort will be made to have the train load reduced in order to favor the engines so that a better average can be made on repairs and coal.

After four years' experience with a tonnage rating, on grades ranging from 40 ft. to 96 ft. per mile, a general increase in the average number of cars hauled per train has resulted. Where 22 cars had been the average trains over some of the heavy grades, 35-car trains are now hauled by the same engine. In another case where 25 cars had been a full train, the tonnage rating has increased the train to 35 cars with the same engine.

When we consider the service of a locomotive from the standpoint of what it can earn, and not what it costs per mile to run it, we shall then begin to increase the number of freight cars per train and arrive at the question affecting the revenue of the company, and that is the cost of hauling a loaded car per mile or cost of hauling a ton of freight one mile. There are very few roads in the west on which the train load could not be increased on some of the districts. An increase of one car, containing 20 tons of freight, in each train will increase the earnings of a locomotive in one year $7,200, and the only additional expense would be 90 tons of coal. Taking the average mileage of a locomotive at 3,000 miles per month, or 36,000 miles per year, we have the revenue of 20 tons of freight hauled the same mileage at 1 ct. per ton per mile or 20 cts. per mile per car. There has been no increase in the wages of the engineer, fireman or trainmen, or for repairs. The only extra expense has been 5 lbs. of coal per car mile. Taking the average tonnage per car for the year on six western roads, which is 11.44 tons per car, the locomotive can earn on this basis $4,118.40, per year for the company more than it did before. By keeping the engine in first-class condition at all times, I believe every locomotive in freight service on our western roads can be made to earn at least $4,000 more for the company, per year, than at present; and the expense will not be increased except for fuel at the average rate of five pounds of coal per car mile.

The problem of to-day with decreased rates is to haul great tonnage in each car and reduce the cost of doing it. The revenue of a railroad is derived from the service rendered by its locomotives. To increase the revenue the locomotives must do more work. The tendency is to increase their weight and size, and there is not enough attention paid to getting increased service from those now owned. The freight earnings largely exceed the passenger earnings, and by directing efforts to hauling increased tonnage the revenue is increased without any great increase in operating expenses. The weight of a train over a division is usually determined by the amount of tonnage an engine can haul over certain grades. In nearly every case increased tonnage can be hauled if the mechanical and transportation departments work together. An increase in the steam pressure of 5 lbs. will, in many cases, take one more car over the grade.

When the mechanical departments of our railroads give the same attention to increasing the train load that they do to making a showing of how cheap they can run the locomotives per mile, they will find they have obtained increased service from the locomotive, decreased the cost of hauling a ton of freight, and increased the revenue of the company. The problem of to-day is, how much does it cost to haul a ton of freight one mile, not what does it cost per mile to run your locomotives.

*Abstract of a paper read before the Western Railway Club, Dec. 17, 1895, by Mr. J. H. McConnell, Superintendent of Motive Power, Union Pacific Ry.

TRAMRAIL CONVEYING SYSTEM AT THE CHICAGO WAREHOUSE OF THE NATIONAL TUBE WORKS CO.

In the accompanying cuts we illustrate a tramrail system recently built at the new warehouse of the National Tube Works in Chicago, Ill., by the Brown Hoisting & Conveying Machine Co., of Cleveland, O. Fig. 1 is a plan of the warehouse showing the routes of the tramrails and railway tracks, the storage rooms, etc. The railway track enters the south end of the building and is depressed below the floor enough so that the car platforms come about the floor level. It will be seen that the tramrail system is so arranged that material can be taken from any car and be carried to any part of the warehouse. The storage rooms are in two stories or rather two floors, the second floor being simply a platform carried by columns. The driveway is therefore open to the roof. From this plan the general scheme of the system will be clearly understood.

Taking the system up in more detail, it consists of 650 ft. of 7-in. I-beam track, six curves and switches and six Brown roller-bushed 1-ton trol-

leys. Four of the trolleys are provided with 1-ton Weston triplex pulley blocks and two with ½-ton blocks of the same pattern. The tramrail on which the trolley runs is supported from the roof timbers at intervals of about 15 ft. Where such supports come under 3 in. × 12 in. timbers they consist of small steel channels placed parallel, with cast iron separators between them, which are fastened to the timbers by lag screws, entering deeply into

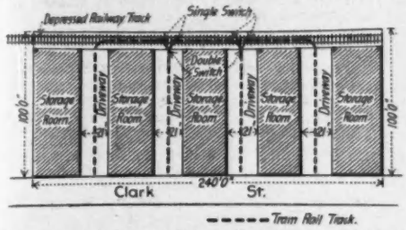


FIG. 1. Sketch Plan of Chicago Warehouse for National Tube Works Co., Showing Arrangement of Tram Rail Conveying System.
Brown Hoisting & Conveying Machine Co.,

the wood. The wrought iron strap hangers, which in their turn support the I-beams constituting the tramrail, are fastened to the channels by means of bolts. Where the point of support for the tramrail comes directly under heavier timbers, 10 × 12 ins., the channels are not used but the wrought iron hangers are fastened to the heavy timbers by bolts running clear through them. These means of support are simple and strong.

Figs. 2 and 3 show the general construction of the switches, trolleys, pulley blocks, etc. It will be noticed that the trolley wheels are made as large as possible, occupying, practically all the space between the flanges of the I-beams. The one ton trolleys also have roller bearings to decrease the frictional resistance. The illustrations show the construction and operation of the switches quite plainly. Fig. 2 is a single switch and Fig. 3 a double switch. These switches are operated from the floor by pendant chains, and are fitted with automatic safety stops making it impossible for the trolley to run off the rail through an open switch.

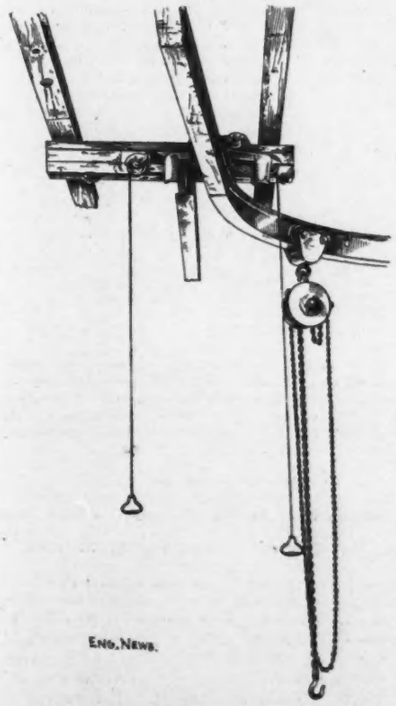


Fig. 2. Brown's Single Switch and Tram Rail Trolley, National Tube Works Co.'s Warehouse.

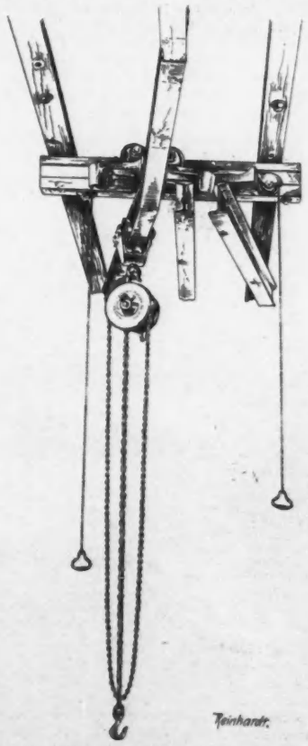


Fig. 3. Brown's Double Switch and Trolley, National Tube Work Co.'s Warehouse.

We are indebted to the Brown Hoisting & Conveying Machine Co., Cleveland, O., for the information and photographs from which our description and illustrations have been prepared.

THE RIKER'S ISLAND CRIBWORK.

By Peter Elbert Nostrand, M. Am. Soc. C. E.

Having been called upon by the Commissioners of Accounts of New York city to examine the condition of the cribwork recently built at Riker's Island, the writer found there a condition of affairs which he believes is of interest to engineers, for the reason that failures are always instructive as guides to future work. The cribwork is about 4,800 ft. long and is arranged in plan as shown in Fig. 1. It was built to add land to Riker's Island for city purposes and as a place of deposit for the ashes, garbage, etc., of New York city. The Department of Docks, which planned and built the crib, claims that any structure that would hold such material from washing away, no matter what its condition may be when filled behind, answers the purpose. The crib was built upon soft mud, except at the shore ends, which were upon sand. The plan of the crib as built was as shown in Figs. 2 and 3.

The following description of the construction is extracted from the specifications:

Top width of cribwork 16 ft. Throughout its entire length the cribwork will be built to conform to the bottom. The first full bottom course will consist of rough logs placed longitudinally of the crib in 5 or 6 rows according to depth, equally spaced and not exceeding 7 ft. between centers; below mean low water the front row will be double with a proper break of joints. Upon these rows of logs round log ties will be placed transversely of the crib, running from front to rear in single lengths spaced vertically over each other about 8 ft. centers longitudinally and properly notched down upon the lower logs; from these ties up to about mean low water mark the crib will be similarly built up of alternate longitudinal and transverse rows of logs, with the proper batter on front and rear of about 3¼ in. to the foot. The bottom will be shaped to the bottom of the river below the first full bottom course of the crib with similar alternate longitudinal and transverse rows of logs; the transverse logs to be shortened in each case as required to meet the bottom, and the longitudinal logs to be spaced as required by the length of the transverse logs," as shown by Figs. 2 and 3.

The logs were of spruce, pine or cypress, of regulation sizes and properly spiked. Each alternate bay was provided with a close flooring of logs not less than 6½ ins. diameter at the small end, though this flooring was omitted in alternate bays. The cribwork was built up to 5 ft. above mean high water; the floored bays filled with stone and the crib sunk in place, after which the open bays were filled up with stone and fender piles were driven on the outer

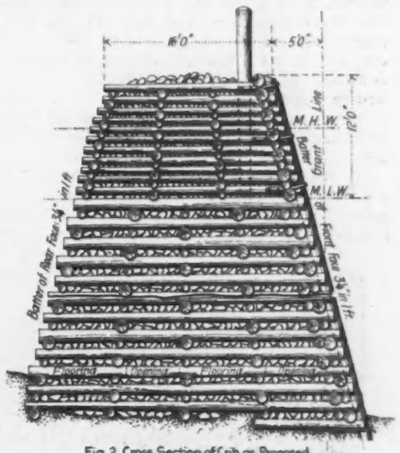


Fig. 2. Cross Section of Crib, as Proposed by Dock Department.

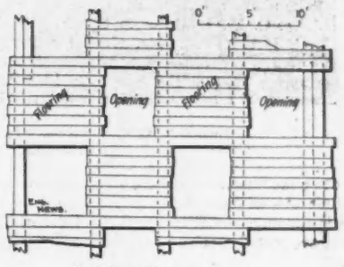


Fig. 3. Plan of Proposed Floor in Crib.

Department Plan of Cribwork.

face at every other bent and properly connected. The timber furnished and the workmanship seems to have been good.

The mud foundation was level in places and at other points sloping, the slope where the crib is in its worst condition being about 10 ft. in the width of the crib at the bottom of 35 ft. as shown in Fig 4.

The result of this method of construction and the partial filling in behind the cribwork is that for about 400 ft. the cribwork is forced over on its back as shown by the photograph and sections.

For 1,200 ft. the crib has been forced an average of 35 ft. outside the grant lines and for 2,000 ft. it is 25 ft. outside the grant line. An average section, excepting the short approaches, would be that shown on the left of Fig. 1; and at high water long stretches of the crib are out of sight, covered by the water.

The inclosed space is only partly filled; if ever completely filled the crib will be forced over far out beyond the grant lines. No anchors or returns were built to hold this long crib and no preparation was made to level up the bottom or reach a firmer bottom.

The unstable condition of the section, Fig. 2, as built on a sloping bottom, is manifest. On a soft bottom it must necessarily assume the position shown in the left on Fig. 1, as any additions on its inner edge forces it further over until finally we have the condition of Fig. 5.

The writer is of the opinion that to make this general method of crib construction successful here the following changes would have been necessary:

1. Crib built with a level bottom.
2. Dredging sufficient to furnish a level and firmer foundation and greater front pressure when built.
3. Returns or anchors built as a part of the

cribwork at frequent intervals.

4. All pockets floored on the inside half of the crib, any open pockets left for stone filling alone to be on the outside half.

5. Careful filling next the crib to drive the mud wave to the shore.

It should be mentioned that the investigation below water level of this cribwork was made by Mr. Otto H. Klein, Jr., submarine engineer.

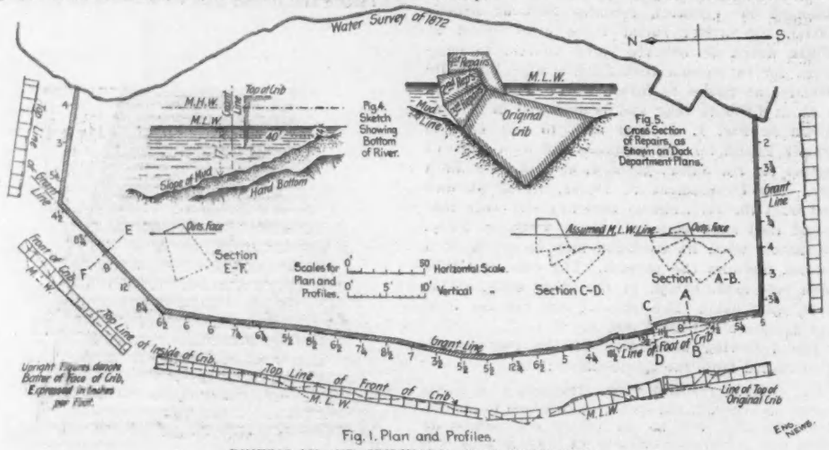


Fig. 1. Plan and Profiles.

RIKER'S ISLAND CRIBWORK; NEW YORK CITY.

According to our usual custom we submitted a proof of the above article to Mr. George S. Greene, M. Am. Soc. C. E., Engineer in Chief of the New York Dock Department. Mr. Greene returns the following reply:—

In the spring of 1893 the city authorities desired to fill in upon the flats upon the westerly side of Riker's Island, with the refuse material of the Department of Street Cleaning. It was necessary to have a retaining structure to prevent this material being washed away. It was neither necessary or desirable to build a boulevard, speedway, or wharf, but simply a retaining structure at a minimum of cost.

Two methods were considered, after due and proper examination of the location, both upon the same principle. One was to make a rip-rap embankment by filling in with stone of various sizes until the embankment stood at an elevation of about 5 ft. above mean high water mark. The other was to build a crib-work retaining structure upon the same general principle of building it up until it stood at the same elevation above mean high water mark. The crib-work could be done cheapest, and, therefore, that method was selected.

Settlement, of course, was expected, and in the first contract for doing the work, it was referred to particularly in the specifications, and the contactor was required to build up the crib-work until it stood at an elevation of about 5 ft. above mean high water mark, for a period of 60 days. After the expiration of that period, the risk of further settlement was assumed by the city.

In the summer of 1894 the filling in with the refuse material of the Department of Street Cleaning having created a nuisance, was stopped. It has not since been renewed, and, consequently, as there was no need of the retaining structure, it has not been completed. At any time when it is desired to do so it can be completed upon the same general principle as that upon which it was begun, namely, that of filling in with rip-rap or with crib-work, or with both, until the settlement ceases and the structure remains at an elevation of about 5 ft. above mean high water mark.

RIKER'S ISLAND CRIBWORK; GENERAL VIEW.

The average amount of refuse annually collected in Paris, says Georges Sitoux, in "La Revue Technique." is about 1,308,000 cu. yds., varying in weight per cu. yd. from 1,162 lbs., in summer to 1,427 lbs. in winter. For a population of 2,400,000 the average amount of refuse per head per year is about 530 lbs. This refuse, until recently, was mainly sold to farmers, special railway rates being made of 50 cts. per ton within a radius of 93 miles. The usual price obtained was very low, being from 15 cts. to 30 cts. per ton on the cars. It thus cost the farmer, with freight charges added, from 65 cts. to 80 cts. per ton. At the present time experiments are being made in Paris to burn this refuse with destructors of the Fryer and Leeds types. The economical Frenchmen, however, do not seem to favor the destruction, by this means, of matter having some commercial value for fertilizing purposes.

Caissons sunk by the aid of a ring of water jets inside the cutting edge are being used for the foundation of the 15-story building to be erected at 12th St. and Broadway, New York city. The caissons are 9 ft. diameter and 27 ft. long. The work has been done by the Hydraulic Construction Co. which employed the same system for building on Broad St., New York city, as described in our issue of July 18, 1895. Mr. Edward Phillips is the engineer.

The Boston high building ordinance, prohibiting the erection of buildings more than 125 ft. in height, has, according to the Boston "Herald" of Dec. 23, been of decided advantage to that city. It has not deterred capitalists from erecting large buidings, but has prevented Boston's narrow and crowded streets from becoming the "cold sunless canyons" which they would become if there were no restriction upon the height.

The sum of $3,020,000 has been appropriated for the Street Cleaning Department of New York city for use in 1896. The appropriation for 1895 was $2,396,000 and Col. Waring asked for $3,187,000 for the current year. The department cleans the streets, and removes and disposes of garbage and ashes.

The establishment of engineering experiment stations at the "Land Grant" State Coleges, endowed by the government under the Morrill Act of 1862, is being urged upon the attention of Congress by Prof. William S. Aldrich, M. Am. Soc. M. E., Professor of Mechanical Engineering at the University of West Virginia, at Morgantown, W. Va. An elaborate paper, showing the advisability of the endowment of such stations, which shall have the same relation to engineering practice that the existing agricultural experiment stations have to farming, was read by Professor Aldrich at a meeting of the Society for the Promotion of Engineering Education, and is printed in the Journal of the Franklin Institute. Professor Aldrich will send copies of this paper, together with other printed matter relating to the subject, on request from anyone interested.

A new cementation process for hardening steel armor plate has been invented by M. Emile Demenge, a French metallurgist. The melted steel is poured into an ingot mould, one of the vertical walls of which is furnished with carbonizing material. The opposite side of the mold is made of a block of iron which cools the steel on that side, preventing the carbonization from extending too deep. A 3-ton ingot made by this process and reduced by forging and rolling to a thickness of 15.75 ins. was found to contain from 1.50 to 1.78% carbon at the surface, gradually diminishing to 0.15 to 0.25 carbon at 3.9 ins. from the surface.

Japan is said to be negotiating with Armstrong & Co., of England, for the establishment of a dockyard and gun factory in Japan. The terms proposed are that 20% of the labor should be English and 80% Japanese; the government would grant an annual subsidy and reserve the right to purchase the plant after a term of years.

The method of preventing electric street railway accidents adopted by the Steinway Electric Ry. of Long Island City, N. Y. is worthy of adoption by troley and cable car lines in general. In accordance with the report of the [illegible] were paid each moterman and conductor who got through the year without an accident to his car. The full prize was given to 98 men and lesser prizes were given to 94 men who served less than a year; over $4,000 in all being distributed.

A combination of the zinc smelters of the country, under practically one management, it is reported from St. Louis, will go into effect on Jan. 1. The money involved is about $2,000,000, which will be furnished by New York and Connecticut capitalists. The combination controls 14 plants. It will put the production of slab zinc in the United States in the hands of three companies.

A blow at combinations in Missouri is reported in the same press dispatches which inform us of the formation of the zinc combination noted above. In the Circuit Court at Clayton in a case in which the National Lead Company is interested, a decision was rendered under which it is impossible for any trust or combination to sue for money due on merchandise sold on credit in the State.